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NIKE MISSILE BASE C-84
East of Quentin Road
between Lake Cook Road
and Long Grove Road
Vicinity of Barrington
Lake County
Illinois

HAER No. IL-116

WRITTEN HISTORICAL AND DESCRIPTIVE DATA

REDUCED COPIES OF MEASURED DRAWINGS

Historic American Engineering Record
National Park Service
Department of the Interior
Denver, Colorado 80225-0287

HISTORIC AMERICAN ENGINEERING RECORD

NIKE MISSILE BASE C-84

HAER No. IL-116

I. INTRODUCTION

Location:	Nike Missile Base C-84 is located east of Quentin Road, between Lake Cook Road and Long Grove Road, vicinity of Barrington, Lake County, Illinois. The base is approximately two miles southeast of Lake Zurich and twenty-five miles northeast of Chicago.
Quad:	Lake Zurich, Illinois
UTM:	A: 16/412300/4667590 (Administration Building) B: 16/413520/4667240 (Battery Control Area)
Construction:	1956
Deactivation:	1963
Present Owner:	Lake County
Present Use:	The base is not presently being used, and is for sale. The underground missile storage magazines were previously used as an archival storage facility by the Lake County Museum.
Significance:	Constructed during the Cold War, Nike missile bases were an ever-present reminder to U.S. citizens that the peace gained after World War II was fragile. Following the war, the U.S. Army constructed Nike air defense systems around forty U.S. cities and military installations as protection against air attack by the Soviet Union. At its peak in 1963, the Nike defense system included approximately three hundred batteries in the U.S. All of the bases have been deactivated and many destroyed.

This Historic American Engineering Record (HAER) documents the role of Nike Missile Base C-84 in the defense of Chicago, Illinois. Base C-84, which was one of 23 Nike installations that comprised the Chicago-Gary Air Defense System, was active from 1956 to 1963. Base C-84 was designed to accommodate Ajax missiles, the first generation of Nike missiles. Due to the size of the missile storage areas and the cost of conversion, the larger and more powerful Nike Hercules missiles were never deployed at Base C-84.

This HAER report is a result of an interagency agreement between the National Park Service, Rocky Mountain Region, and the Corps of Engineers, Chicago District, which provided the funding. In mid-1991, the Preservation Services Division of the Illinois Historic Preservation Agency, as a result of a Section 106 review, determined that the extant Nike bases in Illinois were eligible to the National Register of Historic Places. Nike Missile Base C-84 (Barrington) and Nike Missile Base SL-40 (Hecker) were chosen as the best representations of Nike bases in Illinois, and a HAER report was completed for each site.

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II. DEVELOPMENT OF THE COLD WAR

At the end of World War II, Americans hoped for peace and an end to the trauma of the previous fifteen years of depression and war. Victory in World War II had led to a period of prosperity and growth for America, but did not result in a sense of security. Within five years after the war, the United States would rebuild its recent enemy, Germany, and create an alliance to oppose its former ally, the Soviet Union. The Soviet Union and the United States soon engaged in a Cold War, each side convinced the other was plotting its destruction.

The roots of the Cold War dated on the Soviet side to American intervention, 1918-1920, in the Russian Civil War against the Bolsheviks, and subsequent non-recognition of the Soviet regime until 1933. For Americans, suspicion of the Soviets was rooted in the Bolshevik calls for world revolution, the mass purges of the 1920s and 1930s, and the cynical Soviet-German Non-Aggression Pact of August 1939 that led directly to the outbreak of war and a new partition of Poland. During World War II, disputes over the timing of the invasion of France, and differing visions of the shape of post-war Europe exacerbated these tensions.

During World War II, the Western Allies and the Soviet Union left many issues unresolved in order to maintain harmony among themselves. President Franklin D. Roosevelt recognized the divisions between the Soviet and Western Allied views of post-war Europe, especially regarding eastern Europe. But he saw no way to resolve Soviet desires for a completely secure western border - namely, one under complete Soviet control - with Allied public expectations that the Soviets would live up to the broad ideals of the Atlantic Charter, including the principle of self-determination. Although much of the American public and Congress took the Atlantic Charter seriously, Roosevelt feared risking domestic political consensus if the intentions of the Soviets became known. Roosevelt also feared the loss of unity among the Allies if the U.S. insisted on applying the Charter to conditions in eastern Europe, where the U.S. had no practical means of applying pressure.

Disagreements between the United States and the Soviet Union went back to the summer of 1941. While the Red Army reeled in retreat, Soviet leader Joseph Stalin demanded territorial concessions during Allied discussions of post-war aims. Stalin wanted to keep the territory taken from Poland and Finland in 1939 and 1940, as well as the Baltic states of Estonia, Latvia, and Lithuania. Before the Teheran Conference in November 1943, Averill Harriman, U.S. Ambassador to the Soviet Union, briefed President Roosevelt on Soviet objectives. Harriman told Roosevelt that the Soviets would insist on their 1941 frontiers and were determined to have a friendly government in Poland.[1] At the same time, domestic political pressures restrained Roosevelt from making the Soviet aims clear to the American public. Congressmen with Polish-American constituencies worried about the fate of Poland long before Teheran. In August 1943, Representative John Dingell of Michigan told Roosevelt that "we Americans are not sacrificing, fighting, and dying to make permanent and more powerful the Communistic Government of Russia and to make Joseph Stalin a dictator over the liberated countries of Europe."[2] Fearing loss of support in the 1944 elections, and also fearing that Congress might refuse to join the United Nations over this issue, Roosevelt kept the issue quiet. However, he could be blunt when necessary. In the summer of 1943, the President warned Polish Ambassador Jan Ciechanowski that the United States would not fight Stalin to prevent the taking of eastern Poland or the Baltic States.[3]

Disagreements between the two sides became obvious during the Yalta Conference in February 1945. Roosevelt essentially gave Soviet leader Joseph Stalin a free hand in eastern Europe because he knew there was no way to prevent it. Roosevelt understood that the American public would not have supported a new war against the Soviets in order to save eastern Europe. However, when the reality of Soviet policies became obvious, the reactions of the American public and Congress against the Soviets were predictable.[4]

On February 9, 1946, Stalin gave a rare public address in which he suggested that future wars were inevitable until the ultimate triumph of communism. The West reacted with dismay. *Time* magazine characterized Stalin's remarks as, "The most warlike pronouncement uttered by any top-rank statesman since V-J Day." Supreme Court Justice William O. Douglas described the speech as "the Declaration of World War III."[5] At the same time, Stalin was refusing to withdraw Soviet troops from Iran and Manchuria, violating war-time promises.

Also in February 1946, the Canadians arrested twenty-two people for espionage on the behalf of the Soviets. Searching for a rationale to explain Soviet behavior, the administration of President of Harry S Truman queried the U.S. Moscow Embassy staff. George F. Kennan, minister-counselor at the Embassy and a twenty-year veteran of the Foreign Service, replied with the "Long Telegram," an eight thousand-word explanation of the sources of Soviet conduct. Kennan argued that Soviet hostility to the West would last as long as the Soviet regime was based not so much on ideology but on the need to justify dictatorial rule. Kennan pointed out that the tsars had also claimed dangers from abroad as justification for harsh methods at home. The implication was clear: Soviet behavior was based on the Soviet system's needs, not on Western actions. Hence, negotiation would have little effect towards resolving problems. Kennan suggested that the U.S. had little choice but to strengthen the West, resist Soviet expansion, and wait for internal changes in the Soviet Union. Kennan later named this policy "containment."[6]

Shortly after Kennan's telegram, Winston Churchill visited the United States, theoretically as a private citizen as his party had been voted out of office the previous summer. In a speech delivered at Westminster College on March 5, 1946, Churchill lamented that "from Stettin on the Baltic to Trieste on the Adriatic an Iron Curtain has fallen across Europe."[7] Though he was not the first to use the term, he made it famous. Later that month, the Soviets and the

Western Allies had their first post-war direct confrontation, over Iran. During World War II, the Allies had occupied Iran to prevent the pro-German Shah from aiding the Axis. The British and Americans occupied southern Iran; the Soviets occupied the north. Both sides agreed to evacuate within six months after the end of the war. While the Americans and British pulled out of Iran, the Soviets delayed and began supporting a Soviet puppet government in the northwest, Iranian Azerbijan. Stalin backed down only after increasingly harsh criticism from the United States and fear of embarrassment at the United Nations.

In February 1947, the British informed President Truman they were giving up part of their sphere of influence in the eastern Mediterranean, specifically Greece and Turkey. Greece was in the midst of a civil war between the royalist government and communist guerrillas, and Turkey was under continuing pressure from the Soviet Union to revise the Montreaux Convention, which limited Soviet access to the Dardanelles Straits and the Mediterranean. Together, these countries needed over $400,000,000 in immediate aid, which the British could not afford. In requesting funding from Congress, President Truman characterized the war in Greece as a Soviet Union attempt to penetrate the Aegean region and establish control in the Middle East. In addition, Truman stressed, "I believe that it must be the policy of the United States to support free peoples who are resisting attempted subjugation by armed minorities or by outside pressures."[8] Congress approved the $400,000,000 for Greece and Turkey. This policy, soon known as the Truman Doctrine, committed U.S. assistance to any country struggling against communism. Containment had officially replaced the wartime alliance with the Soviet Union.

In June 1947, Secretary of State George C. Marshall presented a program for European economic recovery in a speech at Harvard University. The program called upon European nations to cooperate in a plan of mutual assistance and pledged support from the United States. In March 1948, Congress voted to fund the Marshall Plan to aid Europe. Though many in Congress objected to the eventual $12 billion cost, this was less than the Defense Department budget for one year.[9] The Soviet Union, as well as Eastern European governments controlled by the Soviets, refused to participate in the plan, and were suspicious of its financial controls and coordination. This refusal helped cement the division of Europe into eastern and western blocs.

The Berlin Crisis of 1948-1949 highlighted Cold War tensions. After World War II, Germany had been partitioned into four Allied occupation zones: American, Soviet, British, and French. The weak and dependent Germans were unable to support themselves. This situation suited the Soviets, who wanted to keep Germany from ever again becoming a threat. The Western Allies wanted a rejuvenated Germany able to contribute to the European economy, and proposed currency reform among the occupation zones to revive commerce and regularize financial matters. When the Soviets refused, the Western Allies went ahead with the reform within their own zones. This move sealed the division of Germany into East and West. On

June 24, 1948, the Soviets isolated Berlin, which was ninety miles inside the Soviet zone, from all ground traffic.

While the United Nations debated the crisis, President Truman decided to use aerial transport to bring fuel and food to the desperate Berliners in "Operation Vittles." Thousands of World War II pilots were called back into service to deliver 4,500 tons of supplies per day, making more than 250,000 flights.[10] The blockade and airlift ended eleven months later when the Soviet Union gave up, in May 1949.[11] However, the damage was done. The Berlin Blockade, together with the 1948 communist coup in Czechoslovakia, convinced many Americans that Stalin would seize every opportunity to expand Soviet control. Cold War tensions further escalated in May 1949, when Chinese communists were victorious over the Nationalist Chinese, driving Chiang Kai-Shek's forces to refuge on the island of Formosa. Since most Americans believed Mao Zedong's communists were Soviet-directed, the communist victory in China only worsened America's strained relationship with the Soviets.

Since the end of World War II, the U.S. had been seeking to ensure peace in two ways: seeking collective security through the United Nations, and creating a series of regional military alliances. In reaction to Soviet moves in Europe, the U.S. committed to permanent stationing of American troops in Europe, reversing a two hundred year-old policy, ever since George Washington warned against foreign entanglements. This also meant a large peacetime military establishment, another reversal of policy dating back to the end of the American Revolution. In 1947, the United States entered its first formal foreign alliance since the French Alliance in 1778 when, with nineteen other Western Hemisphere nations, it signed the Rio Pact.[12] In 1949, at the urging of the United States, the North Atlantic Treaty Organization (NATO) was formed. This new alliance included the United States, the United Kingdom, Canada, Iceland, Norway, France, Italy, Portugal, the Netherlands, Denmark, Belgium, and Luxembourg. Greece and Turkey were added in 1952, and West Germany in 1955. Each signatory pledged to regard an attack on any of them as an attack on all of them.[13] By banding together, the West could hope to begin to match the numerically superior Red Army. Indeed, this was the only way for the United States to "get tough with Russia" without building an enormous military structure by itself. By joining NATO, America committed itself to containing the Soviet Union within the territories it occupied in 1949.[14]

Early in 1950, the National Security Council (NSC) predicted the policy of containment would become world-wide and would require an enormous build-up of American armed forces. The Council issued document NSC-68, which forecast containment as endless war until the collapse of the Soviet Union, requiring endless American commitment. The size of this proposed military build-up appalled Truman, as it would require $40 billion annually, a tripling of the defense budget.[15] However, in June 1950, communist North Korea invaded South Korea; the ensuing war lasted until 1953 and concluded with an armistice, not a peace. Convinced that North Korean ruler Kim Il Sung invaded South Korea at the direction of the Soviet Union, the

Truman administration saw the war as a test of containment and evidence of the worldwide conspiracy of monolithic communism. With the support of Congress and the American people, Truman began the military build-up urged by NSC-68.

The Soviet Union did not form the Warsaw Pact with its satellite countries until West Germany joined NATO in 1955. The status of Germany had remained a major source of division between the United States and the Soviet Union. Between 1945 and 1955, the U.S. pumped $3.5 billion in economic aid into West Germany and achieved a working agreement for German rearmament with Chancellor Konrad Adenauer's Christian Democratic Party. Although many Western European leaders and the German Social Democrats opposed German rearmament, President Dwight D. Eisenhower's Secretary of State, John Foster Dulles, was intent upon using Germany as the cornerstone of the NATO alliance. In May 1955, NATO formally accepted West Germany as a member. Eight days later, angry Soviet leaders concluded the Warsaw Pact with their Eastern European wards.[16]

After the death of Joseph Stalin on March 5, 1953, Nikita Khrushchev came to power in the Soviet Union. Stalin had been sufficiently brutal to frighten many people, including many leaders of Western Europe. He had also doubled the size of the Soviet Army and increased defense expenditures by fifty percent after the beginning of the Korean War. Khrushchev gave a far friendlier impression, traveling through Europe, giving press conferences, and "affirming the need for `peaceful coexistence.'"[17] Nonetheless, in April 1953, Secretary of State Dulles remarked that "nothing that has happened, or which seems to me likely to happen, has changed the basic situation of danger in which we stand."[18]

In October 1953, President Eisenhower approved an NSC memorandum stating that, despite Stalin's death, "Soviet rulers can be expected to continue to base their policy on the conviction of irreconcilable hostility between their bloc and the non-communist world." While noting that "many" Europeans "tend to see the actual danger of Soviet aggression as less imminent than the United States does," the memorandum declared that "in the face of the Soviet threat," the United States should maintain "a strong military posture, with emphasis on the capability of inflicting massive retaliatory damage by offensive striking power."[19] These views seemed confirmed by the use of tanks against street demonstrations in East Germany that year. Nonetheless, the new Soviets leadership made several peaceful gestures in 1955 – evacuating their occupation zone in Austria after signing a peace treaty, and withdrawing from their naval bases at Hanko in Finland and Port Darien in Manchuria. Still, many Westerners viewed these moves as deceptive, rather than conciliatory. Certainly, the Soviets returned to their more brutal methods in November 1956, when they responded to a democratic revolution in Hungary by sending in 200,000 men and 4,000 tanks of the Red Army, crushing all resistance.[20]

On September 2, 1949, the Soviet Union exploded an atomic bomb, several years ahead of

U.S. intelligence estimates. This shocked Americans who had perceived the Russians as technologically behind the United States. Rather than accept that intelligence predictions about the Soviet bomb program had been wrong, many Americans looked for a more sinister explanation. The suspicion that perhaps America was being betrayed, perhaps even within the United States, fell on fertile ground. The 1945 Amerasia magazine spy case, in which classified documents were found in the office of a radical Asian affairs publication, was one of several espionage or alleged espionage incidents that heightened concern in the U.S. about communist infiltrators. In 1947, President Truman initiated the Federal Employee Loyalty Program, under which all federal employees had to undergo loyalty investigations. Undertaken to head off accusations of disloyalty in the government, the program convinced many people that there must be disloyalty present - else why the need for the investigations? A hysteria developed concerning the possibility of Russian spies in the United States, especially after the Alger Hiss-Whittaker Chambers case, and the Julius and Ethel Rosenberg trial and execution for espionage.

In 1950, Senator Joseph McCarthy played on these fears and claimed to have a list of 205 communists in the State Department. He later changed the number to fifty-seven and then eighty-one. After McCarthy began accusing the Army of harboring communists - and even called George Marshall a traitor - censure by the Senate ended his "witchhunt." This end, however, came too late for the American citizens who lost their jobs to guilt-by-accusations from McCarthy or the House Un-American Activities Committee (HUAAC). From 1947 to 1956, 2,700 government employees were fired and another 12,000 resigned under pressure.[21]

When the Soviet Union exploded a hydrogen bomb in August 1953, only ten months after the first U.S. H-bomb test, fear and a sense of urgency increased in the United States. The hydrogen bomb was thousands of times stronger than an atomic bomb. The development of H-bombs also made ballistic missiles more practical, as pinpoint accuracy was not necessary for such a powerful explosion. Consequently, the "unstoppable" German V-2 missile from World War II became a desirable model for future weapons development. As nuclear stockpiles increased, the U.S. encouraged citizens to build fallout shelters and created civil defense systems designed to cope with nuclear attack.[22]

During the 1950s, the United States continued creating regional alliances as containment became global. In December 1954, President Eisenhower signed a mutual defense treaty with the Nationalist Republic of China, losers in the Chinese civil war. The Southeast Asia Treaty Organization of 1954 (SEATO), signed by the United Kingdom, France, Australia, New Zealand, the Philippines, Thailand, and Pakistan, pledged mutual defense against aggression and extended this pledge to South Vietnam, Cambodia, and Laos. The United States also organized several short-lived attempts to enlist various Middle Eastern nations in the cause of containment, such as MEATO and the Baghdad Pact. The Eisenhower Doctrine of 1957 pledged U.S. aid to any government in the Middle East threatened by Communist attack or subversion and this sparked U.S. intervention in Lebanon in 1958. Secretary of State Dulles submitted a memorandum regarding the Middle East to the Foreign Relations Committee explaining the logic of the Eisenhower Doctrine:

> *The Soviet Union aspires to control the Middle East, not because it needs or is dependent upon the resources or the transportation and communications channels of the area, but because it sees control of the area as a major step toward eventually undermining the strength of the whole free world. Africa might well be the first major objective. Control of the oil of the Middle East would almost insure control of Europe . . . The Middle East offers an avenue for aggression against India, West Pakistan, and the Asian countries which lie to the east of them.*[23]

Hence, Dulles argued, containment must be a part of U.S. Middle Eastern policy. Containment, by this time, had become, as predicted by NSC-68, global and apparently endless.

The Cold War reached a frightening peak during the Cuban Missile Crisis of October 1962. After Marxist leader Fidel Castro took over Cuba in 1959, a goal of U.S. policy was to depose him. In 1961 an American-backed invading force of Cuban exiles met with embarrassing failure at the Bay of Pigs. Following the failed invasion, Castro cooperated with Soviet Premier Khrushchev in secretly installing Soviet intermediate range ballistic missiles in Cuba, which threatened most of the continental United States and upset the strategic status quo. The response of President John F. Kennedy brought the America and the United States to the brink of war. Kennedy demanded Soviet withdrawal of the missiles, and announced a naval blockade of Cuba. After several days of rising tension, Kennedy and Khrushchev reached a compromise: The Soviets agreed to remove their missiles from Cuba, and the United States would withdraw their missiles from Turkey. This crisis scared both governments and provided motivation to gain more control over fast-moving events - including the installation of the "Hot Line" between the White House and the Kremlin in 1963.

III. DEFENSE OF U.S. CIVILIAN POPULATIONS DURING THE COLD WAR

As the frightening events of the Cuban Missile Crisis illustrated, the Cold War created fears regarding the protection of American citizens and the nation's cities and military/industrial centers. Initially, the major threat was seen as manned bombers, which America had deployed with devastating effects against Hiroshima and Nagasaki, Japan, at the end of World War II. The first generation Nike missile, the Ajax, was designed to intercept and destroy manned bombers. The second generation, Nike Hercules, was capable of destroying both aircraft and missiles. Nike Zeus, the final Nike missile, was aimed at intercontinental anti-ballistic missiles.

In the event that the Cold War turned hot, Nike missiles were designed to provide the last line of defense for the nation's population and industrial centers. Ringed around major metropolitan centers throughout the United States – and located in inconspicuous, low-scale installations that blended in with the surrounding farmlands, parks, and suburban residential areas in which they were typically located – the Nike weapon system was a "backyard" reminder of the fragile state of world peace.

A. SURFACE-TO-AIR MISSILE DEVELOPMENT

The U.S. entered World War II equipped primarily with three-inch antiaircraft artillery guns, but increasing aircraft operational altitudes soon made these guns obsolete. In 1938, the U.S. had initiated development of an integrated antiaircraft defense system. That investment resulted in the development of the 90mm gun, which was standardized in February 1940. Using the M-9 director radar system, the 90mm gun could hit aircraft flying at 30,000', and the combination of the 90mm gun and M-9 radar proved extremely successful in World War II against the German V-1 rockets. By 1942, the 90mm antiaircraft artillery gun became the basic antiaircraft weapon. The War Department also developed a 120mm antiaircraft gun, but its large size limited mobility.

By 1944, wartime advances in air warfare made it plain that even the latest antiaircraft weapons were not capable of countering future air threats. Guided missiles able to reach high-flying aircraft or rockets, such as the German V-2, were necessary. The atomic bombing of Hiroshima and Nagasaki in August 1945 vividly demonstrated the capability of the newest weapon. As World War II drew to a close, interest grew in the possibilities of new defensive weapons to counter new offensive weapons. In response to potential threats from the air, the Army began developing two separate, but related, pieces of equipment: the M-33 integrated fire control system and what would become the Nike missile.

In 1944, the U.S. Army asked Bell Laboratories to develop a fully integrated radar/computer antiaircraft fire control system. The result was the M-33 system. Earlier systems, such as the M-9, while successful, were a collection of individual equipment elements from various sources that were organized into working units by the military. The M-33 system, however, offered a whole radar/computer system.[24] This system worked with the Nike Ajax missile and provided the basis for improved fire control systems developed later.

B. THE GERMAN V-1 AND V-2 MISSILES

German development and use of the V-1 and V-2 rockets during World War II illustrated the great potential of guided missiles. Designed and tested at Peenemünde on the German Baltic coast, the "V" weapons demonstrated the future of warfare. These weapons were designated the FZG 76 and the A-4, but Hitler hailed them as *Vergeltungswaffe* (vengeance weapons), retaliating for the Allied bombing campaign against Germany. The V-1 was a low-flying subsonic pulsejet missile, essentially a cruise missile, with a high-explosive one-ton warhead. It had a range of 160 miles and flew at 350 mph. Guidance for this aerodynamic missile was very crude but accurate enough to hit large cities.

The V-2 was the world's first rocket-powered ballistic missile and a forerunner of the intercontinental ballistic missile (ICBM). The V-2 had either an integrating accelerometer or a doppler radio system for range control. The integrating accelerometer proved to be simpler and more reliable. By monitoring the velocity of the missile, the integrating accelerometer judged where the missile was and cut off the fuel in flight, thus controlling the range of the missile. The doppler radio system used a similar principle, measuring the range by the velocity of the missile and cutting off fuel at the appropriate time. The V-2 had a range of 190 miles and carried a one-ton warhead. Germany used the first V-1 rockets against London and other English cities in June 1944, and the first V-2s in the following September. In all, the Germans fired 20,880 V-1s and 3,165 V-2s, mainly against London and Antwerp. Over half of the V-1s and nearly all of the V-2s reached their targets.[25]

Still, the M-9 director, together with the 90mm gun and the SCR-584 radar, played a crucial role in defending London against the V-1. The M-9 system was deployed along the English Channel and, during a single week in August 1944, 89 of 91 V-1s launched by the Germans from the Antwerp area against London were shot down by heavy guns controlled by M-9s.[26]

During World War II, German rocket scientists also developed several guided missile systems for antiaircraft use. Though none were finished by the end of the war, the designs were impressive. The Wasserfall, when completed, would have had a speed of 1,800 mph, a range of 16.5 miles, an infra-red homing device, and a self-contained guidance system.[27]

Virtually the entire design staff at Peenemünde, including Wernher von Braun, were brought to the U.S. after they surrendered to American troops in March 1945. V-2 designer Von Braun - who was once arrested by the German Gestapo for remarking that he was more interested in designing missiles for space exploration than in building missiles to bolster Germany's war effort - signed a contract with the U.S. Army. Von Braun served as technical advisor to the White Sands Proving Ground and as technical director to Fort Bliss, Texas (where the Nike weapon system would later be tested). Von Braun became chief of guided missile development in 1950, when the project moved to Redstone Arsenal in Huntsville, Alabama. In 1956 he became director of development/operations of the Army Ballistic Missile Agency at Huntsville, Alabama.

C. THE NIKE MISSILE FAMILY

On August 17, 1944, First Lieutenant Jacob W. Schaefer submitted a memorandum proposing the design of a rocket guided from the ground. Schaefer suggested a system designed around two radars linked to a computer. One radar would track the target, transmitting to the computer current location points. The computer would calculate future target positions and be able to relay to the missile, through the other radar, any course corrections needed in order to intercept the target. The Army sent copies of Lieutenant Schaefer's technical proposal to Radio Corporation of America (RCA) and Bell Telephone Laboratories (BTL) for their consideration.[28]

In May 1945, Bell Laboratories presented a verbal report to the Army on "Project Nike," named after the winged goddess of victory in Greek mythology. Bell Laboratories' written document, "A Study of an Antiaircraft Guided Missile System" (AAGM Report), was released the following July. The report, which was the work of a small close-knit group of scientists and engineers that included W.A. McNair, H.W. Bode, G.N. Thayer, J.W. Tukey, and B.D. Holbrook, stressed swift deployment of a weapon system that could combat the latest high-speed, high-altitude bombers. The engineers recommended a weapon that was derived, to every extent possible, from existing technology. In order to save time and money, the Bell Laboratories' engineers also recommended that the missile be as simple and inexpensive as possible. They also recommended that the more expensive and complex equipment, such as the radar system, should remain on the ground, where it could be re-used and have benefit of routine maintenance.[29]

Basically, the Bell Laboratories' report recommended that Project Nike be comprised of a supersonic rocket missile that would be vertically launched under the thrust of a solid-fuel booster, which would be dropped on completion of its function. The launched missile would be propelled by a liquid-fuel motor, and would be guided to a predicted "intercept point" in space. The commands for missile detonation would be controlled from the ground, and would be transmitted by radio signals from a ground-based computer and radar system that would track both the target and the missile in flight.[30]

A few months later, the Antiaircraft Artillery Board published a report that listed more specific characteristics of the Nike missile. The board wanted a missile that: 1) had an ability to operate effectively up to altitudes of 60,000' and at ranges of 50,000 yards; 2) was able to destroy large bombardment-type aircraft when detonated within 60' of the airplane; 3) had a self-destruction feature; 4) had the highest degree of security against interference or enemy electronic countermeasures; 5) was transportable by motor vehicle; and 6) had an assembly period of no more than three hours.[31]

In June 1945, the Army Ordnance Corps (co-sponsored by a division of the Army and the Air Force) assumed full responsibility for Project Nike, and named Western Electric and Bell Laboratories as the prime contractors for development of the missile radar system. As designed by Bell Laboratories and Western Electric, the Nike Ajax missile command and control radar system incorporated many characteristics of the M-33 antiaircraft fire control system, saving both time and money on research and development, production, logistics, and personnel training.[32] The Army selected Douglas Aircraft Company (later the McDonnell Douglas Astronautics Corporation) as the major subcontractor for the design of the missile, booster, and launcher. Following the start of the Korean War in 1950, the Department of Defense asked the contractors to produce a working version of the Nike system as soon as possible. This first missile was the Nike Ajax.

D. THE NIKE AJAX MISSILE

The Nike Ajax was the first in the Army's family of guided missiles, and was the world's first operational, guided, surface-to-air missile system.[33] The first Nike Ajax site was activated in December 1953, at Fort George G. Meade, Maryland. The 36th Antiaircraft Artillery (AAA) Missile Battalion deployed at this site on March 20, 1954.[34] The name "Ajax" derived from Greek mythology, where there were two Ajax characters, both swift, skillful, brave, and strong. The Nike Ajax was a two-stage, supersonic missile. The whole missile was extremely slender, only 12" in diameter. It was 21' long, and 34' high with the booster attached, and weighed slightly over 2,455 pounds.[35] Nike Ajax carried three high-explosive warheads, weighing 12, 179, and 122 pounds, each wrapped in 1/4" optimum cubic fragments. The warheads were mounted in the nose, center, and aft sections of the missile. Two arming mechanisms and five detonating cords activated the warhead, following burst orders issued from the ground by a computer.[36]

The Nike Ajax missile had two stages of propulsion. The first-stage, solid-propellant booster produced a 59,000-pound thrust for 2 1/2 seconds, then separated and fell away as the second stage fired. A liquid-fueled sustainer motor powered the second stage. It burned jet fuel, JP-4, with red fuming nitric acid (IRFNA) as the oxidizer. As JP-4 and red fuming nitric acid are not self-igniting, a small quantity of aniline/furfuryl alcohol (and later dimethyl hydrazine) provided the catalyst for combustion.[37] In flight, the sustainer motor burned for 70 seconds and consumed 135 kilograms of JP-4.[38] The Nike Ajax had a burnout speed of Mach 2.3, with a range twenty-five to thirty miles and a ceiling of 65,000'. (Mach 1 is the speed of sound; Mach 2.3 is 2.3 times as fast as the speed of sound, or 1,679 mph.)

The Nike Ajax had three sets of cross-shaped fins, in addition to those on the booster. The forward set of fins was for steerage, the middle set was mounted with sensing equipment, while the rear set provided stability. Douglas Aircraft manufactured the Nike airframes and assembled the missiles at an Army Ordnance Missile Plant in Charlotte, North Carolina. In total, Western Electric and Douglas Aircraft produced 358 ground batteries and 14,000 Nike Ajax missiles for the Army during the duration of the missile's deployment.[39] In addition to Western Electric, Bell Laboratories, and Douglas Aircraft, the U.S. Army subcontracted with hundreds of other companies to supply parts for the Nike Ajax weapon system. Contracts executed for Nike Ajax were valued at approximately $1.16 billion. Research, development, and design engineering came to approximately $179.2 million; industrial services and supplies cost about $947.6 million; and the remaining $39.1 million was invested in production facilities.[40]

The last operational Ajax site in the United States ceased operations in May 1964, and the last missile of the Nike-Ajax type was offered to the Smithsonian Institute by the Army in November 1964.[41] However, beginning in 1967, Nike Ajax installations were deployed in countries that shared common defense interests with the United States, such as Belgium, Denmark, France, West Germany, Greece, Italy, Japan, the Netherlands, Norway, Taiwan, and Turkey.

E. THE NIKE HERCULES MISSILE

The Army began developing the next generation of Nike missile, Hercules, in 1953, the same year that Nike Ajax became operational. Aircraft capabilities had increased in range and altitude, demanding a more sophisticated missile system. In addition, nuclear payloads were a greater threat. Designed to carry either nuclear and/or high-explosive warheads, the Nike Hercules missile could attack supersonic aircraft operating at altitudes in excess of 150,000' and at a range of more than eighty-seven miles.[42] The Army named the missile for one of the most celebrated heroes of classical mythology, a figure renowned for strength, courage, and endurance.

Whereas the Nike Ajax was 34', the Hercules was 41', attaining more power and the ability to carry a nuclear warhead. The diameter also grew, from 12" to 31.5". The solid-fuel booster for the Nike Hercules was a cluster of four Nike Ajax missile booster units. Another improvement was a solid-fueled propellant that replaced liquid-fueled propellant for the sustainer motor. At launch, the Nike Hercules weighed 10,405 pounds, later versions weighed 10,710 pounds. Burn-out speed was typically Mach 3.5 in early production and 3.65 later.[43] The acquisition radar for the Nike Hercules system was a modified and improved version of that used in the Nike Ajax system, and ultimately had a range of one hundred miles. The missile and target tracking radars were also similarly modified to increase their ranges.[44]

In 1958, the Army began replacing Nike Ajax missiles with Nike Hercules. An "Improved Nike Hercules" system became operational in 1961. The Improved Hercules was designed to combat yet more sophisticated offensive weapons, including aircraft bombers that could reach speeds of Mach 2 and altitudes of 70,000', as well as air-supported missiles and rockets operating at velocities of Mach 3 and altitudes of 100,000'. The High Power Acquisition Radar (HIPAR) built by General Electric was also an important component of the Improved Hercules system.[45] While the range of standard Hercules radars was 125 miles, the HIPAR of the Improved Hercules system extended the acquisition range of a battery to 175 nautical miles, allowing more than 400 seconds from target acquisition to intercept.[46] With the increasing speed of enemy aircraft and ballistic missiles, every extra moment was essential. The Improved Hercules system also proved effective against surface-to-surface targets and had a limited anti-missile capability. In 1960, a Hercules missile supported by HIPAR scored a direct hit against a Corporal ballistic missile at White Sands Missile Range in New Mexico. Later that same year, a Hercules missile successfully intercepted another Hercules traveling at Mach 7 at a height of nineteen miles.[47]

By June 1958, the Army had converted most of the Ajax batteries around New York City, Washington, D.C., and Chicago to Hercules systems. Funding for the gigantic task of conversion and new production fluctuated between $47.97 and $129.6 million per month. At the peak of the Hercules effort in 1957-60, Douglas Aircraft operated not only the Charlotte Ordnance Missile Plant in North Carolina, but three other Nike Hercules facilities in the same state, at Winston-Salem, Burlington, and Greensboro. At peak production, prices for the Ajax and Hercules missiles were, respectively, $19,300 and $55,200.[48]

Nike Ajax magazines (the underground storage facilities) also needed modification to accommodate the heavier, longer, and wider Nike Hercules missiles. An increase in electrical generating capacity to lift the heavier missile out of the underground storage facility was the primary change necessary in the control area. The fueling facilities at the launching area were required only if the Ajax missile was also to be operational at the base; the solid fuel booster and sustainer motor of the Hercules did not need any liquid fuel. The Army Antiaircraft Command (ARAACOM) developed four different designs to accommodate the changing missile design. In July 1957, the Corps of Engineers noted that:

> Two types of underground storage magazines have been constructed. These are usually referred to as "B" box and "C" box. Distribution of these boxes varies depending upon Department of Army operational concepts in force at time of construction. At least 1 "B" box and in some instance 3 "B" boxes are at each battery location. The "C" box designed for the Ajax is smaller and would require extensive modification to permit the firing of the Hercules missile from the elevator launcher. It can however, be used to store the Hercules and in this manner support the above ground satellite launchers without appreciable loss in firing time. Plans are being prepared to use it for this purpose.
>
> The larger "B" box was designed to accommodate the Hercules missile. Some modifications of these magazines is needed because of changes made in the missile and its launcher.
>
> Construction needed in the launcher area is in two categories:

1. Modification of the launcher elevator system to increase lift capacity and the provision of new foundations and blast apron to mount the new satellite launchers.

2. Provision of new safety features unique to atomic installations.[49]

Type of Pit	Designed For	Launcher on Elevator	Length of Pit	Width of Pit
A	Ajax	Yes	42 feet	63 feet
B	Ajax/Hercules	Yes	49 feet	60 feet
C (converted Hercules from A)	Hercules	No	42 feet	63 feet
D	Hercules	Yes	62 feet	68 feet

After 1958, the Army constructed all of its Nike facilities with magazines designed specifically for the Nike Hercules, the "D" box.

F. THE NIKE ZEUS MISSILE

Nike Zeus was the third missile in the Nike family, and brought Nike development into the ICBM era. Named for the ruler of the Greek Gods, the Zeus missile measured 63' 3" in length, had a diameter of 60", and weighed 40,000 pounds at launch. The tandem booster, designed by Thiokol, had a thrust of 450,000 pounds, then the highest ever attained through a single nozzle. The Zeus had a range of more than 250 miles. The Nike Zeus system also included the Zeus Acquisition Radar (ZAR), a significant improvement over the Nike Hercules HIPAR system. Similar in shape to an Egyptian pyramid, the ZAR featured a Luneberg lens receiver aerial weighing about 1,000 tons. After several test firings, the first successful intercept of an ICBM by Zeus was in 1962, at Kwajalein in the Marianas Islands.[50]

Despite its technological advancements, the Department of Defense terminated Zeus development in 1963. Although the system had a $15 billion price tag, the Nike Zeus system had several technical flaws, including an inability to distinguish enemy warheads from chaff, reflectors, and other types of decoys.[51] Still, the Army continued to develop an anti-ICBM weapon system – referred to as "Nike-X" – that was largely based on the technological advances of the Zeus system. Nike-X featured phase-array radars, computer advances, and a missile tolerant of skin temperatures three times those of the Zeus. In September 1967, the Department of Defense announced the deployment of the Sentinel antiballistic missile system; its major elements were available from Nike-X development. In March 1969, the Army deployed the Safeguard program, which was designed to defend Minuteman missiles, and which was also based on the Nike-X system.[52]

G. THE AIR FORCE BOMARC MISSILE

At the same time that the Army developed the Nike system, the Air Force created its own air defense system: BOMARC, which was the first active-homing, surface-to-air missile system. In 1958, the Air Force installed BOMARC bases at Dow AFB, Maine; Otis AFB, Mass; McGuire AFB, N.J.; and Suffolk County AFB, N.Y. Later, the Air Force upgraded those bases with improved versions of BOMARC, and also installed BOMARC systems at Kincheloe AFB, Michigan; Duluth Municipal Airport, Minnesota; Niagara Falls Municipal Airport, N.Y.; and at two Royal Canadian Air Force bases, North Bay, Ontario, and La Macaza, Quebec.

Boeing designed the BOMARC missile system. Depending on the version, BOMARC missiles ranged in length from 49' 3" to 43' 9", had a diameter of 35", a span of 18' 2", and weighed between 15,000 and 16,000 pounds at launch. Range varied between 230 and 440 miles.[53] The missiles were stored horizontally on launchers and housed in shelters. The missile system connected into the SAGE (Semi-Automatic Ground Environment) network and could be launched within two minutes of SAGE acquiring a suitable target. Later, that time was cut to thirty seconds. The BOMARC weapon system had no pre-programmed guidance. The missiles were launched vertically by booster rockets. Within seconds, the missile's ramjets ignited and the aerodynamic controls became effective. At a target distance of about ten miles, the radar on the missile's nose locked on to the target, cutting out SAGE control, and homing the missile by itself. BOMARC missiles could carry either conventional or nuclear warheads.[54]

In 1958, illustrative of the competition that soon developed between the Army-deployed Nike Hercules system and the Air Force's BOMARC system, Air Force officials called for a plan to replace the Nike bases surrounding Chicago with three BOMARC bases at Madison, Wisconsin; Duluth, Minnesota; and Kinross, in upper Michigan. As the Chicago Sun Times reported:

> *The basis of the Air Force plan is a charge that the atom-tipped Nike-Hercules, already stationed at one site in Chicago cannot cope with Russia's fast new jet bombers. Army*

> *officials rebutted this contention with the "hard fact" that the Hercules is already operational and easily adaptable to existing bases, while the BOMARC is distinctly a weapon of the future.*[55]

Charging the Air Force with "planning in World War II terms," the Army predicted that by the time the BOMARC system was fully combat-ready, Soviet bombers would no longer be the major threat to American security. The Army claimed that by 1960 "the main Russian threat will be the ICBM and its answer is the Army's Nike-Zeus.[56]

In 1959, the Department of Defense conducted a mock attack on Chicago to evaluate the effectiveness of the Nike Hercules. The test was conducted for the Defense Department's Weapons Systems Evaluating Group (WSEG), with Strategic Air Command (SAC) bombers carrying out the simulated attack. The Nike Hercules was only 8% effective against these bombers. Air Force officials used this event as an opportunity to push the BOMARC missile.[57] Ultimately, however, the Department of Defense utilized both missile systems for America's air defense, although there were far more Nike than BOMARC bases.

IV. AIR DEFENSE ORGANIZATIONS DURING THE NIKE PERIOD

Prior to World War II, the possibility of America being attacked by enemy air attack was remote. Protected on both sides by oceans, and with the limited range of aircraft, America seemed insulated from European or Asian air attack. In February 1934, British Prime Minister Winston Churchill voiced concerns about the potential air bombardment in England in the event of war. Although small inroads had been made regarding U.S. air defense, it was only after the Japanese attack on Pearl Harbor that America devoted serious attention to the nation's air defense.

America's first air defense military organization devoted entirely to air defense was the Air Defense Command (ADC), which was created by the War Department on February 26, 1940, at Mitchel Field, New York, following a recommendation by Major General Henry H. "Hap" Arnold. In November 1939, Arnold had pointed out the weaknesses in America's air defense system. The Air Defense Command was formed to "conduct experiments in the northeastern states to determine how fighter planes, antiaircraft artillery, and an air warning system could be integrated into a single air defense network."[58]

New to the problem of air defense, the Air Defense Command looked to the British example. In August and September 1940, during the Battle of Britain, the British had shown that a well-dispersed air force was a difficult bombing target, and demonstrated the value of an early warning system based on radar.[59] The United States undertook several large-scale exercises that attempted to unify all air defense elements. On the basis of this experimentation, the Air Defense Command recommended that the United States follow Britain's practice of placing air defense responsibility under pursuit aviation commanders.[60]

On March 7, 1941, the War Department assigned the mission of air defense to the Army Air Corps. The Army Air Corps created four numbered air forces, each with an interceptor command assigned the mission of air defense. The numbered air forces retained responsibility for organization and planning, while the interceptor commands carried out air defense operation. These air defense operations included control of antiaircraft artillery (AAA) units trained and administered by the Coast Artillery Corps, which was charged with the mission of developing antiaircraft artillery weapons and techniques.[61] However, lack of funds and commitment prevented these units from becoming part of a unified, fully prepared air defense system.

The bombing of Pearl Harbor on December 7, 1941, caught the United States by surprise, and dramatically illustrated the weaknesses of the American air defense command. The nation was forced to implement an air defense system that was still in its infancy, only eight months had passed since the Air Corps had received overall responsibility. Early in 1942, the Army reorganized into three principal elements: the Army Ground Forces, the Army Air Forces, and the Army Service Forces. Each received separate but related duties.[62]

As the United States entered the war, little doubt existed concerning the important role antiaircraft artillery would play. On March 9, 1942, the War Department activated the Antiaircraft Command as part of the Army Ground Forces. Major General Joseph A. Green became its first commanding general. The Antiaircraft Command's primary mission was "to instruct and train officers and enlisted men for duty with antiaircraft artillery and barrage balloon units, and to activate, organize, equip and efficiently train such units for combat service."[63] The War Department located the Antiaircraft Artillery School at Camp Davis, North Carolina. Two years later, the school moved to Fort Bliss, Texas, where the clear weather and solitude provided excellent year-round antiaircraft training and testing grounds. Between March 9, 1942, and September 2, 1945, the command trained 613 antiaircraft artillery combat units for deployment overseas and in the continental United States.

The Army Service Forces, through the Chief of Ordnance and Chief Signal Officer, played a significant role in the procurement, delivery, and maintenance of air defense equipment.[64] The Army Air Forces also maintained operational control of air defense through its four numbered air forces. However, this organizational structure caused difficulties. In 1942, the Army Ground Forces and the Army Air Forces had "sharp disagreements" concerning the circumstances under which an antiaircraft artillery unit could begin firing.[65] Each side argued that it should have the command to control the antiaircraft artillery units. The issue,, however, remained unresolved and would surface again with the development of the Nike missile system.

As the Nike missile began development in 1945, there was still confusion over the control of air defense systems. Wartime experience demonstrated that antiaircraft units fired on any intruding aircraft, including "friendlies." The Army Ordnance Corps had full responsibility over Nike development, but the Air Force had overall responsibility for the air defense of the United States. In 1946, the War Department issued several directives that led to different interpretations by the Army Air Forces and Army Ground Forces. Ultimately, the War Department resolved the controversy in September 1946, by deciding that Army Air Forces would control antiaircraft artillery units with air defense missions. It also determined that the Air Defense Command would provide Army Ground Forces with some degree of influence by integrating antiaircraft artillery officers into its staff. Army Ground Forces would remain responsible for providing the technical training of the antiaircraft units.

The 1947 National Security Act separated the Army Air Force from the Army and established it as the United States Air Force (USAF). Prior to this point, the military had been divided into the War Department and the Navy Department, each with its own Cabinet official. Separate from the National Security Act, the Army and the Air Force formulated over two hundred agreements regarding air defense. These agreements became known as the Eisenhower-Spaatz Agreements, and concluded that the Air Force would have operational control of air defense, while the Army would staff the air defense units. In September 1947, as part of the Eisenhower-Spaatz Agreements, the Army gained control over the development of missiles "designed for employment in support of Army tactical operations," known as point or local defense, while the Air Force was assigned "missiles designed for employment in area air defense"[66]

The assignment of research and development for guided missiles – whether for area or point defense – to two services, created not only rivalry but a duplication of effort. Duplication was rationalized as a means of maximizing America's ability to have the flexibility to adjust a weapons system design to changing technological innovations and political circumstances.[67] That this duplication was allowed to continue can be understood in the context of Cold War fears of the early 1950s.

The spread of Communism appeared to be a threat, as the communists, through several elections, had gained control in several Eastern European countries. The Korean War had commenced and finished with no clear victory. Ernest Yanarella, in his book, The Missile Defense Controversy - Strategy, Technology, and Politics, 1955-1972, noted that: "The fears of war breaking out at any moment, the perception of a hostile and potentially aggressive enemy capable of inducing heavy loss upon North America, and the belief in the vast potency of a military technology capable of rendering obsolete whole weapons systems - all these attitudes promoted duplication [of weapon systems] as a lesser evil to the possibility of unpreparedness."[68]

As a result, the Army and the Air Force developed separate missile programs, even though both branches of the military had worked together at the time Bell Telephone Laboratory was awarded a contract in 1945. The contract, co-sponsored by the Chief of Ordnance and the Army Air Forces, was to "explore the possibilities of a new antiaircraft defense system to combat future bombers invading friendly territory at such speed and altitude that conventional artillery would be unable to defend against them effectively."[69] However, the Air Force eventually withdrew its support for the Bell Laboratories program and initiated programs of its own. While the Army continued to work with Bell Laboratories on the development of Nike, the Air Force undertook a series of studies that eventually led to the development of the BOMARC missile. The Air Force sponsored GAPA (Ground-to-Air Pilotless Aircraft), a Boeing project to design a ramjet vehicle capable of a range of 35 miles and an altitude of 60,000'.[70] The General Electric Corporation's project "Thumper" studied interceptor weapons for ballistic missile defense. "Wizard" was a University of Michigan contract to study the development of a supersonic missile capable of reaching an altitude of 500,000'.[71] In February 1946, the Air Force awarded Boeing, together with the University of Michigan, the design contract for the BOMARC missile. The name "BOMARC" was derived from Boeing Airplane Co. and the Michigan Aeronautical Research Center.

President Harry S Truman, in an effort to strengthen America's air defense, directed the Air Force to reorganize in October 1948. The Continental Air Command (ConAC) was formed on December 1, 1948, headed by Lieutenant General George E. Stratemeyer. The Air Defense Command fell under the Continental Air Command jurisdiction, which meant that the Air Force still maintained overall responsibility for air defense. The Army was obligated to provide antiaircraft artillery units and personnel to support the air defense function. Disagreements continued between the Army and Air Force over responsibilities.

One concession the Army won was to establish an antiaircraft artillery chain of command, which became the Army Antiaircraft Command (ARAACOM). The Army activated ARAACOM in 1950, immediately after the Korean War erupted. ARAACOM was based at Ent Air Force Base at Colorado Springs, Colorado, and initially had only planning and training oversight. On April 10, 1951, ARAACOM assumed actual command of Army air defense units. By July 1951, ARAACOM headquarters commanded a total of thirty-eight antiaircraft artillery battalions. The Army manned half of those battalions, while the rest were manned by the Army National Guard.[72]

The Continental Air Defense Command (CONAD) was a unified command under the Joint Chiefs of Staff and performed overall air defense of the continental United States (CONUS), including Alaska. The Air Force had executive control and controlled firing of the missiles. ARAACOM became the Army's contribution to CONAD in August 1954. Army air defense forces in Alaska, however, remained under a separate command (U.S. Army, Alaska) rather than being subordinate to ARAACOM.[73]

In January 1956, Secretary of Defense Charles Wilson assigned ARAACOM exclusive responsibility for surface-to-air missiles used in point defense, including the Nike Ajax missile, which had been deployed since 1954. On March 21, 1957, ARAACOM was redesignated the Army Air Defense Command (ARADCOM). The term "antiaircraft" was no longer favored, as air defense was targeted against both aircraft and missiles. ARADCOM units defended major industrial and population centers of the United States, as well as selected Strategic Air Command (SAC) bases. Army Air Defense Command Posts were established for each defense at battalion, group, or brigade level.[74]

Even before ARAACOM was redesignated ARADCOM, it took measures to improve the ability of its Nike Ajax units to react to an enemy attack. ARAACOM instructed defense commanders to take the following actions:

a. Maintain 25% of all Nike batteries "capable of launching one effectively controlled missile <u>within fifteen (15) minutes</u> of receipt of signal or warning, and of maintaining sustained fire until the supply of ready missiles is exhausted."

b. Maintain 50% of all Nike batteries "capable of launching one effectively controlled missile <u>within thirty (30) minutes</u> of receipt of signal or warning, and of maintaining sustained fire until the supply of ready missiles is exhausted."

c. Permit 25% of all Nike batteries to be on a training and maintenance cycle, retaining the "capability of returning to an operational status <u>within two (2) hours</u> of receipt of signal or warning."[75]

These measures, designed to improve operational readiness, had a far reaching effect. Nike batteries assumed a combat-like readiness. Fifteen-minute status permeated the atmosphere of a Nike base. A siren meant an exercise, a readiness test, or an attack; one never knew. As Nike units had to meet these requirements twenty-four hours a day, they assumed an ever-increasing feeling of responsibility for the nation's defense.

In September 1957, the U.S. Continental Air Defense Command, which included ARADCOM, became part of NORAD, the joint American-Canadian North American Air Defense Command. The NORAD commander was a U.S. Air Force general, who was responsible for coordinating all continental air defense activities.[76] Although each of the component forces provided combat-ready air defense units for operational control by NORAD, the commanders of each component retained command, administration, training and logistical control over their respective force.[77]

ARADCOM strength peaked in 1963, with 184 on-site firing units (134 Regular Army, 50 National Guard). However, the command was subjected to almost annual realignments and reductions. In February 1974, the Defense Department announced that ARADCOM would be inactivated, except for the 31st Air Defense Artillery Brigade, which had been activated during the Cuban Missile Crisis. By December 31, 1974, ARADCOM's remaining regional headquarters, including eight groups, thirteen battalion headquarters, and forty-eight Hercules firing batteries, were closed out. ARADCOM headquarters were inactivated on January 4, 1975.[78]

V. NIKE BATTERIES

A. SITE SELECTION

Nike installations were designed to protect the nation's major population and industrial centers from enemy attack. In 1955, the Army announced that thirty sites had been designated as top priorities, all located in or near major cities: Washington-Baltimore, New York, Chicago, Detroit, Philadelphia, Hanford (Washington), San Francisco, Los Angeles, Seattle, Norfolk, Pittsburgh, and Niagara-Buffalo. The Department of Defense chose these sites because of their dense population, and industrial and/or military characteristics. In most cases, these sites were already protected by 90mm and 120mm antiaircraft guns.[79] Ultimately, the Army constructed over three hundred Nike sites in twenty-eight states: Alaska, California, Connecticut, Florida, Georgia, Hawaii, Idaho, Illinois, Indiana, Iowa, Kansas, Louisiana, Maine, Maryland, Massachusetts, Michigan, Minnesota, Missouri, Nebraska, New Jersey, New Mexico, New York, Ohio, Pennsylvania, Rhode Island, Texas, Virginia, Washington, and Wisconsin. (A list of the cities and sites protected by Nike installations can be found in section XII.)

Nike was originally designed to be a mobile weapon system. As such, Nike's battery control and launching areas were both intended to be above-ground facilities, fulfilling Army requirements that Nike missiles be as mobile as antiaircraft guns. However, Army safety regulations also governed the surface storage of explosives. As a result, each Nike base required at least 119 acres of land. In October 1952, just three months before Nike equipment began rolling off production lines, Army personnel responsible for land acquisition realized that the needed acreage would be very difficult to secure. The needed land was both costly and scarce, particularly if it was located in or near metropolitan areas – the primary locations for Nike bases.[80]

In an effort to reduce the amount of needed land, the Army examined the possibility of placing Nike launcher facilities underground. An underground installation decreased the real estate requirements to forty acres of land, since the battery would be considered a magazine. The feasibility of such a modification was confirmed during 1953, when a prototype underground

Nike installation was built at White Sands Missile Range. Test firings proved successful in June 1953, and the Army decided to employ underground launcher installations at all Nike bases within the continental United States. Even though underground installations were chosen as the primary system, the Army continued to design the Nike system for dual application. One version was a fixed installation. The other version adapted to mobile field use. The mobile system, transported by road or aircraft, could be ready for action in seven hours after arriving at a base.[81]

The site selections for Nike facilities involved several phases of planning, design, and evaluation. A fundamental military principle was that a circular defense provided the best protection. As such, Nike installations were designed to ring the cities and industrial centers, referred to as the "vital areas" (VA) that they were to protect. Each vital area was surrounded by a buffer zone, the size of which was determined by the amount of damage the enemy could theoretically inflict, as related to the ability of the area to absorb damage and continue operating effectively. Army experts soon found that no two sites were exactly the same. Although each Nike installation included essentially the same facilities, the configuration varied from base to base. Preliminary siting plans were sent to ARAACOM Headquarters at Colorado Springs, Colorado. These plans were then forwarded to the Pentagon, where final approval was given.[82]

As part of the planning process for Nike deployment, Army technicians plotted bomb release lines around each vital area. The horizontal distance that a bomb would fall, forward from the release point to detonation, was dependent principally on the speed and altitude of the releasing aircraft and could be determined by using bomb release distance graphs. By judging the possible altitudes and speeds of enemy aircraft, a critical line was determined around the vital area, beyond which the defense had to be able to destroy all enemy aircraft and deny enemy penetration.

The Army then determined the number of Nike installations required to effectively deny enemy penetration. Attack assumptions, defense characteristics, and command specifications were the parameters for this determination. The number of missiles required against each target was determined, and this number was modified by operational reliability factors. These factors included the reliability of the missile system, prevailing climate conditions, technical support, crew proficiency, terrain difficulties, and maintenance schedules. Using various formulas and tables, Army tacticians determined the required numbers of units.

Technical experts placed Nike missile installations at sites where they could best deter mass attacks from a single direction and, at the same time, maintain the most effective capability against multiple attacks from different directions. Army engineers and surveyors conducted a map and ground reconnaissance of the terrain in each area where Nike facilities were sited. Utilizing a "defense in depth" concept, some Nike units were located well out from the vital area; others were close in. The location of the units was a compromise between moving inward to maximize firepower against a massed attack, and moving outward to increase early destruction and effectiveness against multiple attacks. Ideally, the Nike installations would offer mutual support, as one Nike unit covered the "dead area" of its adjacent unit.

Sixteen radial direction-of-attack lines were drawn equidistant through the center of the vital area. The effectiveness of the defense was analyzed by placing the threat, or aircraft, over the intersection of the direction-of-attack line and the bomb release line. The number of missiles fired from each unit under the threat was recorded and then totaled for that direction-of-attack line. This was done for each direction-of-attack line in order to check whether the defense was balanced with approximately the same strength against each direction of attack. In sectors where strength was low, units were moved closer to that direction-of-attack line or outward toward the approaching target. In sectors where the strength was relatively high, units were moved away from that direction-of-attack line or inward. A guide for determining balance was that no direction-of-attack would have more than plus or minus ten percent of the average number of missiles fired.[83]

Army tacticians also plotted a "kill contour," which was determined by locating the points where the required number of missiles necessary to kill the estimated threat, as determined in the planning phase, was achieved. This was done by moving the threat, or aircraft, inward toward the bomb release line until the number of missiles needed to kill the threat, was obtained. The kill contour was compared to the bomb release line and indicated the adequacy of the defense. It was also used to compare different choices of unit positions, as each set of positions would generate a different kill contour. Each contour was labeled with the number of aircraft kills achieved and the speed and altitude of the portrayed attack. Additional analyses, such as the number of targets the defense was capable of killing, were also performed.

The battery control area of each Nike installation, which contained the guidance and control equipment, had to be located between a minimum of one-half mile and a maximum of three miles from the associated launching area. The minimum distance was determined by the maximum tracking capability in elevation of the missile tracking radar, and the maximum distance by practical considerations of providing communications by cables. The launchers were oriented to make use of a common disposal area, within which the expended booster cases would fall. The Army was careful to select a booster disposal area that minimized danger to Army personnel and property, as well as the surrounding property and civilian population. An adequate disposal area was established as a circle of one mile radius with the center located about one and one-half miles from the nearest launcher section or populated area.[84]

Despite the reduced real estate requirements that resulted from the conversion to underground launchers, the construction of Nike installations fell behind schedule because of public opposition. No one particularly wanted "push-button warfare devices" installed in their neighborhoods.[85] Civic officials, real estate groups, farmers, and homeowners objected to the installations for several reasons: fear of falling debris from booster cases, reduction in real estate values, damage to crops, and the possibility of a missile misfire or explosion.[86]

Initially, the Army's public relations problems stemmed, in part, from government security regulations that prohibited surveyors and engineers from disclosing why they wished to examine a landowner's property. In some instances, the surveyors were denied access. Eventually, Army officials realized that they had to permit a "minimum of intelligence" to be released to area residents.[87] Press reports also raised concerns about the safety of the missiles. On April 6, 1953, Time magazine commented:

> *While doing their defending duty, the Nikes will not be desirable neighbors. The boosters that bounce them into the air are big enough to do damage when they fall to the ground, and so are the Nike themselves . . .*[88]

Eventually, the recognition of the needs of national security prevailed, and there seemed to be an understanding between the armed forces and the neighborhoods and communities surrounding the Nike installations. In November 1955, the Chicago Sun-Times reported:

> *The reaction has varied from vigorous protest to indifference and ignorance of what is under way. But the Army is making a valiant public relations attempt to tell the public what it's up to and temper the shock of the American civilian population's first direct contact with radar and guns.*[89]

The Army acquired most of the land for Nike installations through purchase, declaration of taking, and straight condemnation. Whenever possible, the Army utilized government-owned land, which also reduced cost and land acquisition concerns. On December 17, 1953, a Department of Defense press release stated that the use of government land could "reduce to a minimum, inconvenience to the civilian population and the removal of revenue-producing land from tax rolls."[90] In several cases, existing military installations were converted to Nike use.

B. SITE SELECTION FOR THE CHICAGO DEFENSE AREA

The Army designated Chicago as Priority No. 3 for Nike Ajax installations, following Washington, D.C., and New York.[91] Prior to the construction of Nike bases to defend the Chicago area, antiaircraft artillery battalions, armed with 120mm and 90mm guns, were already present in and around Chicago. In April 1954, the Army Corps of Engineers advertised for construction contracts for the first Nike bases in the Chicago area: C-93 (near Skokie, Illinois), C-45 (Gary, Indiana), and C-51 (Alsip, Illinois). In addition, C-03, C-41, C-40, C-61 (Lemont), C-44 (Wolf Lake), C-80 (Arlington Heights), C-72 (Addison), C-49 (Homewood), C-92 and C-94 (Libertyville), and C-98 (Ft. Sheridan) were to be deployed by the third quarter of fiscal year 1957.[92]

In the Chicago area, the Army utilized park district land for Nike installations as much as possible. Under lease arrangements, Nike installations were situated in Chicago's Jackson Park, Burnham Park, Lincoln Park, Belmont Harbor, and Montrose Harbor. In all, the Chicago Park District leased 88.5 acres of lake front land to the Army at the rate of $1.00 per year per site. The loss of public recreation land and lack of compensation came under criticisms. On March 6, 1956, Major General Carter, chief of the 5th Regional Antiaircraft Command at Fort Sheridan, told the Chicago Daily News:

> *We don't want to take any park land, but we have no alternative . . . a circular defense of the city is best from a military point of view. In lake front cities like Chicago the defense must cut across the "diameter" of the circle, the lake shore. We make every adjustment possible without throwing defense out the window.*

Most Nike Ajax bases consisted of two parcels: the Battery Control Area and the Launch Area. The Launch Area contained the underground missile storage magazines and launch equipment. Buildings used for the maintenance, testing, and firings of the missile were also in this area. As noted above, the Battery Control Area, which contained the radars and computer equipment associated with the Nike system, had to be located a minimum of one-half mile and a maximum of three miles from the associated Launch Area. The housing and administration buildings, including the mess hall, barracks, and recreation facilities, could be located at either area, depending upon the availability of land. At Nike Base C-84, the housing and administrative buildings were located in the Launch Area.

The Army acquired the land for Nike Missile Base C-84, which was located approximately twenty-five miles northwest of Chicago, through a combination of purchase, declaration of taking, and condemnation. During 1956 and 1957, the Army acquired 26.87 fee acres, 54.67 easement acres, and two no-area permits (pole line and sanitary sewer line in public road right-of-way) for use as Nike Missile Base C-84. The base's Launch Area, which was located just east of Quentin Road, consisted of 15.80 fee acres. The Battery Control Area, which was located farther to the east just north of Lake Cook Road, contained 11.07 fee acres. Of the 54.67 easement acres, 0.19 acres were comprised of an access road and utility easement for the launcher and housing area, and the remainder of the 54.59 easement acres were line-of-sight and safety easements.[93]

The cost for Nike Missile Base C-84 was $1,214,502.97, exactly the cost authorized. By June 1962, the Army had constructed twelve Nike installations for the Chicago Defense Area, which cost $13,774,674.11 ($55,071.89 over budget).[94] In all, twenty-three Nike installations were constructed in the Chicago area, although they were not all used simultaneously.

VI. ARTILLERY UNITS INVOLVED IN THE CHICAGO DEFENSE AREA AND NIKE MISSILE BASE C-84

Between 1951-1956, the Chicago Air Defense System was under the jurisdiction of Eastern ARAACOM. In 1957, with ARAACOM redesignated ARADCOM, Chicago defense was placed under the 5th ARADCOM Region. In 1966, following a reorganization, the Chicago Air Defense came under the jurisdiction of the 2nd ARADCOM Region, where it remained until the end of Nike deployment in 1972.[95]

Two Army battalions and the National Guard manned Base C-84. In 1956-1957, the 13th Antiaircraft Artillery Battalion - which earlier had been part of the Chicago defense system of 90mm and 120mm antiaircraft guns - was headquartered at Nike Missile Base C-54 (Orland Park), and served as a Nike-Ajax battalion. On July 16, 1956, the battalion designation was changed to 13th Antiaircraft Artillery Missile Battalion, Nike-Ajax. Also that month, the battalion's D Battery transferred from Base C-71 (La Grange) to Nike Missile Base C-84. Battery A was located at Nike Missile Base C-70; Battery C was at Nike Missile Base C-51.[96]

The 13th Antiaircraft Artillery Battalion was inactivated September 1, 1958,. At that time, the 2nd Battalion, 60th Air Defense Artillery, was activated with headquarters at Nike Missile Base C-54. Through 1959, Nike Missile Base C-84 served as this battalion's Battery D. Battery A was located at Nike Missile Base C-49 (Homewood); Battery C was at Nike Missile Base C-46 (Munster, Indiana). By 1961, Nike Ajax Missile Base C-84 was being manned by a National Guard Unit.[97] By this time, Nike Hercules was the more advanced version of the missile, and several Nike Ajax installations in the Chicago defense system were converted to accommodate the larger and more powerful Hercules missile. However, Base C-84 was not converted. After the 2nd Battalion, 60th Air Defense Artillery became a Nike Hercules battalion, Battery D was relocated from Base C-84 to Base C-61 (Lemont).

In 1961, Colonel R.E. Vollendorff wrote to U.S. Congresswoman Marguerite Stitt Church that "Nike Site C-84 is an active NIKE Ajax Site which is being manned by a National Guard Unit."[98] Indeed, the Department of the Army had planned for the Army National Guide to eventually man fifty percent of the missile sites in the air defense of the nation.[99] In its 1961 annual report, the National Guard listed Chicago as one of 15 CONUS defense areas where Nike-Ajax batteries were being operated by Guard units.[100]

VII. NIKE OPERATIONS WITHIN NATIONAL AIR DEFENSE

The Nike system was part of the joint American-Canadian North American Air Defense Command (NORAD) and the U.S. Continental Air Defense Command (CONAD). Within

NORAD, the Canadian and American air forces were responsible for detecting, identifying (as friend or foe), and destroying or turning back targets. Thus, the Air Force was deployed for area defense. The detection phase began with the identification of intruders through the Distant Early Warning radar system, commonly known as the DEW Line. The DEW Line consisted of a net of radar stations near the parallel of 69E north latitude from northwestern Alaska to northeastern Canada, and was designed to give warning of hostile aircraft approaching from the north.

The United States and Canada jointly built and operated the DEW Line. The DEW Line became operational on July 31, 1957, was extended to the Aleutian Islands in 1959, and across Greenland in 1961. The U.S. Navy and U.S. Air Force provided sea flanks for the DEW Line with radar-equipped aircraft operating from the Aleutians to the mid-Pacific and from Newfoundland to the mid-Atlantic. The DEW Line provided up to six hours of advance warning of aircraft penetrating the northern hemisphere, complementary to the Ballistic Missile Early Warning System (BMEWS) - which since June 1961 had been on guard to detect approaching ballistic missiles.

The DEW Line also alerted the back-up defenses of NORAD, including the Mid-Canada (55th parallel) and the Pine Tree (49th parallel) radar warning and control lines. The Mid-Canada Line was about six hundred miles to the south, built and manned by Canada, and used doppler detection equipment. The U.S. contiguous radar system was extended offshore by the Navy, as well as by Air Force radar-equipped aircraft. In the Atlantic Ocean, Air Force radar platforms (Texas Towers) were part of a system that was tied together by a communication network terminating in the NORAD command post.

The Semi-Automatic Ground Environment (SAGE), an Air Force command and control system, received all data from these radar networks. SAGE centers were located in several sectors and attempted to identify the intruders and transmit intruder locations to Air Force and ARADCOM control and direction centers in the appropriate sector. Hypothetically, when an enemy intruder entered the band of contiguous radar coverage overlapping the United States-Canadian border, SAGE would initiate attack by sending fighter-interceptor squadrons and launching BOMARC missiles. If the area defense provided by these weapons failed, SAGE continued tracking the intruder and passed this information to ARAACOM Nike fire units. Nike batteries then came into play as "the ultimate defense" of the protected localities.[101]

Once notified of an intruder, ARAACOM would alert the appropriate Army Air Defense Command Post which, in turn, would designate one or more Nike batteries to attack the incoming target. The Nike system utilized a command guidance type of control system that revolved around the use of several types of radars and a computer. The target was initially picked up by either of the acquisition radars, the LOPAR (low-power radar) or HIPAR (high-power radar in the Hercules) systems. From the information provided by the acquisition radar, the target tracking radar acquired the designated target and tracked it throughout the engagement. Another radar, the missile tracking radar, locked on the missile prior to firing and tracked that missile throughout its entire flight.[102]

The two tracking radars fed target and missile position data into a computer located in the battery control trailer. Using this information, the computer continuously determined a predicted point of intercept and issued the steering orders necessary to guide the missile toward that point. At the point of "highest kill probability," the computer issued a burst order to the missile. This order detonated the three warheads in the Nike missile simultaneously. The computer transmitted this order to the missile through the missile-tracking radar.

The battery control officer, stationed in the battery control trailer, received all of the information and controls necessary to engage the enemy target. A series of lights and a meter showed the officer the number of missiles prepared for firing, and the progress of the fire unit in accomplishing the steps necessary to prepare and fire the missile. Prior to firing, the predicted point of intercept and the current position of the target were continuously displayed on two plotting boards in the battery control trailer.

With this information, and knowing the rules of engagement and the restricted areas, the battery control officer determined the most advantageous time to fire the missile. After the missile was fired, the two plotting boards illustrated the course of the target and the missile flight path. These plots provided the battery control officer with a graphic presentation of the missile and target flight paths. Controls necessary for premature or delayed detonation of the warheads were incorporated into the system.

The Nike system was designed to operate with four batteries in one battalion. Each battery could acquire and track targets, as well as launch and control missiles. Each battery had three underground storage facilities, which had the capability of firing one missile from the elevator/launcher and three others from satellite launchers loaded from the same facility. As sophisticated as the Nike missile was, however, each battery could only track and fire one missile at a time.

VIII. PHYSICAL DESCRIPTION: NIKE MISSILE BASE C-84

All Nike buildings were built from standardized drawings approved by the Corps of Engineers, most of which were designed by the firm of Leon Chatelian, Jr., of Washington, D.C. The Corps modified each Nike installation, depending on land availability, obstructions, and other criteria. Nike buildings were considered modified emergency buildings. Originally, they were to be pre-fabricated structures, but were rather unsightly and did not contribute to troop morale and, therefore, were changed to modified emergency design.

A. BATTERY CONTROL AREA

(Note: Most of the Battery Control Area for Nike Missile Base C-84 had been demolished by the time of HAER recordation. All that remained standing was the sentry guardhouse.)

The Battery Control Area, often referred to as the Integrated Fire Control (IFC) Area, included all of the necessary radar, computer, and control equipment required to detect and acquire a target, and to acquire, launch, and guide a missile to intercept that target. The Battery Control Area, which required a minimum of ten servicemen to operate, was the focal point for all information and control necessary for successful operation of the battery. Cables connected the various elements within the battery control area, as well as the control area with the launch area. The major buildings and equipment included:

Sentry Guardhouse: Sentry guardhouses were small, square structures with cinderblock walls, which were located at the entrances to all portions of a Nike missile base. In addition, as part of base security, two lines of fencing and a firebreak marked the boundaries of the installation.

Battery Control Trailer: As noted earlier, the Army originally designed Nike to be a mobile system that would be suitable for use with a field army. As deployed for continental air defense, Nike bases were permanent installations. However, the military still wanted the system to be suitable for field use. As a result, the key pieces of the Nike weapon system, such as the radar, launch, and battery control equipment, were in mobile trailers connected through communications cables. Other trailers were used for spare parts, maintenance, and antennae equipment. (NOTE: Prior to the recordation of Nike Missile Base C-84, all of the equipment and control trailers had been removed.)

The battery control trailer contained the battery control console assembly, the acquisition radar cabinet assembly, the computer assembly, an early warning plotting board, and a switchboard cabinet assembly. From this trailer, the battery commander directed the acquisition of targets and the firing of the missiles. The acquisition radar operator and computer operator also were located here.

The battery control console assembly provided the control and displays necessary for the tactical operation of the battery. The assembly was arranged for the following operating positions: the left position for the acquisition radar operator, the center position for the battery control officer, and the right position for the computer operator. Mounted directly above the three positions was the horizontal plotting board and the altitude plotting board, which furnished information received from the missile tracking radar and target tracking radar through the computer. The plotting boards were in front of the acquisition radar operator, which enabled the battery control officer to challenge a target from either position. The plan position indicator, which presented the acquisition radar and identification friend-or-foe signals, was mounted in front of the battery control officer. The controls for tactical signaling within the battery were located in front of the battery control officer. The computer operator's position had controls and information displays pertinent to the computer and plotting boards.[103]

The tactical control signal panel was located below the altitude plotting boards. The panel contained two rows of signal lamps that monitored all essential signal circuits to provide a visual summary of the sequence of events occurring during an engagement. The bottom row of lamps were amber colored and, when lit, indicated the particular events that must occur before the time of missile burst. The top row of lamps were green, and were arranged in three sections from left to right. The lamps in the left and center sections indicated the status of the missile and target tracking radars; the lamps on the right indicated the status of the launching area. The left section of the panel also contained a meter that showed the number of missiles prepared in the launching area.[104]

The acquisition control assembly contained the components of the acquisition radar and its operating controls were located at the battery control console, on a sloping panel directly in front of the three operating positions. The acquisition control panel was located on the extreme left of the sloping panel. The control panel contained various controls, switches, lamps, and meters for monitoring and adjusting the circuits of the acquisition radar. The lower right section of the panel contained controls for the identification friend-or-foe equipment.[105]

The manual early warning plotting board was located on the trailer wall behind the battery control officer. The early warning plotting board operator received information from an early warning radar network, by telephone, and/or radio about all unidentified or enemy aircraft in the vicinity of the battery. Based on this information, the operator then made a manual plot on the early warning plotting board, showing the position of the aircraft.[106]

The switchboard operator in the battery control trailer sat at the event recorder and switchboard cabinet assembly. This position had the controls and indicators necessary for the switchboard operator to expedite the telephone communications within the battery control area and to monitor the event recorder.[107]

Radar Control Trailer: The radar control trailer (often referred to as the central tracking trailer) housed the target radar console assembly, the missile-tracking radar console assembly, the radar power cabinet assembly, the radar range and receiver cabinet assembly, and additional equipment associated with the target and missile-tracking radars.

The target track console assembly provided the control and displays necessary for the operation of the target tracking radar. It had three operating positions: the left position for the target elevation operator, the center position for the target azimuth operator, and the right position for the target range operator. Each operating position had indicators which displayed the target track signals for the particular coordinate and the controls necessary for proper operation.[108]

The missile track console assembly provided the control and displays for the operation of the missile tracking radar. It had one operating position, which was for the missile radar operator. Normally, after the missile tracking radar was energized, the remaining operations were fully automatic. The missile radar operator made sure that the missile tracking radar was performing properly.[109]

Generally, the battery control trailer and the radar control trailer were positioned back-to-back, which allowed easy access to both trailers by operating personnel. The maximum distance between the trailers was 25 feet.

Low-Power Acquisition Radar (LOPAR): This search radar was composed of the acquisition antenna, receiver, and transmitter. The radar rotated constantly at a predetermined speed. Through the acquisition radar scope, the battery commander (or battery control officer) received a pictorial image of an enemy target coming within range of the Nike installation. The battery commander, through electronic interrogation, had to determine whether the target was friend or foe. The acquisition radars of all Nike sites were tied into SAGE, which used computers to assign every intruder to a specific interceptor.[110] The Corps of Engineers indicated that obstructions at some Nike installation sites made it necessary to mount the acquisition and two tracking radars on towers 20' to 40' high. These towers were constructed of a steel reinforced concrete column sheathed in aluminum for even heat distribution.[111]

Target Tracking Radar: The target tracking radar tracked the enemy aircraft's range, direction, and elevation, and transmitted this data electronically to the computer. The radar was composed of the tracking antenna, receiver, and transmitter.

Missile Tracking Radar: This radar was similar in appearance and operation to the target tracking radar. The missile tracking radar tracked the missile automatically throughout its flight, and continuously sent that information to the Nike installation's computer system. In turn, the computer transmitted steering commands to the missile through the missile tracking radar to direct the missile toward its predicted intercept point with the target. Continuous commands were sent to the missile to correct for evasive actions by the target. When target and missile converged, the missile was detonated and the missile tracking radar automatically transferred to the next missile readied for firing.

Generator Building: This building contained the equipment to produce the necessary electrical power to operate the equipment in the fire control area. Commercial power with electrical converters (changers) to change 60-cycle power to 400-cycle power were utilized where available.

Radar Collimation Mast Assembly: The radar collimation mast assembly was composed of: the radar test, which had two track-radar frequency band generators; the radar collimation mast, which was usually 60' tall; the targethead assembly; and cross arms, for correcting bore-sight. The mast assembly was used for collimating (adjusting the line of sight), testing, and adjusting the missile tracking and target tracking radars. Typically, the mast assembly was located 600' from the missile tracking and target tracking radars. Spatially, the mast and two tracking radars formed a tall triangle.

B. LAUNCH AREA

The Launch Area provided for the maintenance, storage, testing, and firing of the Nike missile. The area included the Launch Control Trailer (LCT), a missile assembly and test area, an acid fueling station, a generator building, and three launching sections, each equipped with four missile launchers. The launching sections, which included the underground magazines where the missiles were stored, were lettered A through C. Each section included four missile launchers, numbered 1 through 4. An estimated twenty-one men, including the launching control officer and the section chief, operated launch control. Six missile crew members manned each launching section, and three men were in the Launch Control Trailer.[112]

NOTE: At the time of HAER recordation, the Launch Area at Nike Missile Base C-84 consisted of the following extant structures: sentry guardhouse, administration building, mess hall, barracks, missile test and assembly building, generator building, pump house, paint and oil storage shed, PX (supply store), acid storage shed, acid fueling station, basketball court, underground storage magazines and launcher-loader assemblies, and a water well.

Sentry Guardhouse: The sentry guardhouse at the Launch Area was identical to that at the Battery Control Area, a small, square structure with cinderblock walls.

Administration Building: The administration building housed the administrative support services for the base. The one-story, cinder-block building included a day room, offices for the battery commander and officers, supply room, supply office, hobby room, communications room, barber shop, mail room, restroom, and arms storage room.

Barracks: Nike Missile Base C-84 contained two barracks buildings, which provided living quarters for base personnel. Typical of most Nike installations, one barrack was for launch personnel, the other was for the battery control crewman. The construction drawings indicate that each barrack contained an officers' lounge, non-commissioned officers' lounge, several storage rooms, heater room, restroom, shower room, and large common sleeping room. The barracks, which had cinder-block walls and slanted roofs, were one-story buildings with "L"-

shaped floor plans.

Mess Hall: The mess hall was the common eating facility for personnel stationed at the base. The building included a kitchen, dining area, storage area, and boiler room. The building had cinder-block walls, a slanted roof, and two entry vestibules.

Paint and Oil Shed: The paint and oil shed was very similar in design to the sentry guardhouse, a small square structure with cinder-block walls.

PX (Supply Store): Nike bases often included a PX (Supply Store): The store at Nike Missile Base C-84 is a gable-roofed rectangular building, with sheet metal walls and roofing.

Water Treatment/Sewage Facilities: Typical of all Nike missile installations, Nike Missile Base C-84 had its own water treatment and sewage facilities. Depending on location, these base facilities might include wells, pump houses, sewage lagoons, holding tanks, and/or septic tanks.

Basketball Court: When not on alert, Nike crewmen reported that life at a Nike missile base could be tedious. In order to provide recreational opportunities, the Army equipped each base with a basketball court. In addition, crewmen often played team sports, such as softball, with servicemen from other nearby bases or with teams in the surrounding communities.

Launch Control Trailer (LCT): The launch control trailer, which had been removed from Nike Missile Base C-84 prior to HAER recordation, contained the equipment needed to function as the control center between the battery control trailer and the three launching sections. Similar in appearance to the battery control and radar trailers in the Battery Control Area, the launch control trailer contained the launching control panel, the launching control switchboard, and the test responder. Included within the launching control panel were the controls, displays, and communications equipment necessary to supervise and monitor the activities of the launching sections, and to act as a relay station between the launching sections and the Battery Control Area. Before firing, the launching control console operator selected a section. The launching section then designated a launcher, thus connecting one missile through the launching control building to the battery control area for firing.

Underground Storage Magazines and Launcher-Loader Assemblies: Although they were originally designed to hold six magazines, most Nike bases were comprised of only three underground storage areas. (Some bases that were converted from Nike Ajax to Nike Hercules included both types of missiles.) Each unit had associated launch pads, access areas, and ground electrical units. Each magazine pad had a double elevator door, which swung down towards the inside when opened. Each unit also had several ventilator shafts and a single double-door main entry, with a set of stairs leading down to the magazine. A door at the bottom of the stairs led into the magazine. Emergency escape hatches, with counter-weights for easy opening, led from the underground personnel rooms to the inside. The magazines were made of reinforced concrete. Fresh air for personnel was provided by an air vent unit in the magazine room.

Each underground unit contained a room for storing the missiles (the magazine room), an elevator to carry the missiles to the surface for firing, and four launcher-loader assemblies. Three of the launchers, numbers 2 through 4, were permanently emplaced above the ground and were referred to as satellite launchers. The fourth launcher (number 1) was mounted on the elevator. When the magazine elevator was in its lowered position, the missile crew could push a missile and booster from the storage racks onto the launcher on the elevator. When the elevator was raised, the missile and booster on the elevator could be pushed from the elevator launcher onto the satellite launchers. Nike crewmen could operate the elevator, which could be raised, lowered, or stopped, via a master control station in the magazine room, from the controls on the elevator, or from the launching section control panel in the personnel room. Hydraulic power to operate the elevator and the doors was supplied by an elevator assembly power unit in the magazine room.[113]

During "alert stages," servicemen stationed in the underground launch area lived in the small underground personnel room on a 24-hour basis. The personnel room, which was equipped with bunks, was separated from the magazine by three blast-proof doors. An emergency escape hatch provided direct access to the outside.

<u>Missile Assembly and Test Area</u>: Missiles arrived at Nike bases unassembled and unarmed. Peacetime Interstate Commerce Commission restrictions prevented the transporting of ready missiles from a central assembly site.[114] At the missile assembly area, Nike crews uncrated, assembled, and tested the missiles. The assembly referred primarily to the installation of the missile control fins, main fins, ailerons, and fairings. The missile's hydraulic and propulsion systems were also checked. The crew visually inspected the various components and lines of both systems for correct assembly and serviceable condition. Leak tests were run on the lines and components using compressed air.[115]

Following the system tests, the crew performed a complete missile test. In preparation for this test, crewmen connected the missile to an external source of hydraulic power and to the radio frequency and electrical test sets. The missile was then operated from these external sources. In effect, the missile was made to perform as it would in flight and its performance was carefully observed. After this test, the crew connected the missile to a compressed air source, and both the hydraulic air tank and the propulsion air tank were pressurized. The crew installed a charged battery in the missile guidance section, and conducted a pressure test to assure that it was properly sealed.[116]

The Missile Test and Assembly Building had two large, garage-like doors at either end, through which the missiles were rolled in and out. In addition to the main test and assembly room, the building included a stock room, first aid room, restroom, and boiler room. A concrete walkway for missile movement connected the Missile Test and Assembly Building with the acid fueling station.

Acid Fueling Station: At the acid fueling station, crewmen joined the missile to the booster. Fueling was also accomplished at this station. The fuel servicer, used to fill the missile with fuel, was a crank-operated lift about 12' high. The fuel was hoisted onto this platform, allowing the fuel to flow into the missile by gravity. Likewise, the acid servicer had an assembly that automatically inverted the barrel as it was raised.[117] As protection against the caustic acid, crewmen wore rubber suits during the fueling process. In hot weather this could become quite uncomfortable. For safety in case of explosion, the warheading operation was also performed at this station, which was encircled by an earthen berm eight to ten feet high. The process involved installing two arming devices, the warheads, and connecting these components with the detonating cord.[118]

Warheading Area: For safety in the event of explosion, missile warheading operations were also performed at the acid fueling station, which was encircled by an earthern berm approximately eight to ten feet high. The warheading process basically involved installing two arming devices, the warheads, and connecting these components with the detonating cord.

Acid Storage Shed: Located near the acid fueling station was a metal storage shed. Nearby were shower facilities, in the event of accidental contact with dangerous chemicals and fuels.

Generator Building: Electric power for underground sites was supplied by 150-kilowatt, 60-cycle diesel generators or commercial sources when available. Direct 60-cycle power was used for the elevator. Where 400-cycle power was required, the 60-cycle power was converted to 400-cycle power by means of frequency converters (changers).

IX. FIRING A MISSILE

A. ALERT STATUSES[119]

The battery control officer could determine the action of the battery personnel and the degree of readiness of the battery through four alert conditions denoted by colors: WHITE, YELLOW, BLUE, and RED alert. The alert statuses were displayed by lamps at the operating consoles throughout the battery.

White Alert: A white alert was the standby condition for a Nike battery. Normally, no equipment was operating on a tactical basis, with the possible exception of the acquisition radar. During white alert, routine maintenance, testing, and training was carried on in all areas.

Yellow Alert: During yellow alert, the battery was informed that enemy aircraft may be approaching. At this point, the aircraft's target was unknown. During a yellow alert, Nike personnel manned all stations, and all motor generators and power supplies were energized, with the exception of the high-voltage supplies for the test responder and the missiles.

Blue Alert: The battery control officer ordered blue alert when an enemy attack was determined to be in the direction of the battery's defense area. The launching control officer placed all launching sections "on deck." Each section crew completed ready-to-fire preparations for one missile, and then went to the personnel room in the underground revetment.

Red Alert: When an attack against the battery's defense area appeared imminent, the battery was placed on red alert. The missile vibrator was energized and started the transponder. Everything was now ready for target designation and engagement.

B. SIGNAL INDICATIONS FOR ALERT STATUSES[120]

Each major operating area in the battery was provided with a signal panel, which had a double row of lamps. Each alert status was represented by two lamps. The top lamp was green and, when lit, indicated that the particular alert status had occurred. The bottom lamp was either red or amber and indicated, when lit, that the alert status had not occurred. A red lamp represented an alert status in which direct action was required of the operator for whom the lamp was displayed. An amber lamp represented an alert status in which no direct action was required of that operator.

The battery control officer's display was on the battery control signal panel on the battery control console. It consisted of a master set of signal lamps, which monitored all the essential signal circuits necessary for a visual summary of the state of readiness of the Nike battery. The first series of lamps on the battery control officer's display, three pairs, pertained to the missile. The DESIGNATED green light indicated that the missile had been designated; the READY green light, that the missile was ready, and that the launching area was prepared for firing the missile; and the TRACKED green light, that the missile tracking radar was satisfactorily tracking the missile and that the launching area and the missile tracking radar were ready.

The next series of lamps, four pairs, described the target status. The FOE light indicated that the battery control officer had identified the target as a foe. The DESIGNATED light indicated that it had been designated a target to the three target tracking radar operators. The

CONFIRMED light indicated that the target tracking radar operators had recognized the designation and that steps had been taken to acquire the target. The TRACKED light indicated that the target was being tracked in range, azimuth, and elevation.

The READY TO FIRE light summarized the above two series of lamps; that the missile was ready and tracked; that the target was identified as a foe and tracked; and that the computer was settled and that all was prepared for the battery control officer to press the FIRE button. The green FIRE, LAUNCH, and BURST lamps lit in their respective sequence after the FIRE pushbutton was pressed.

C. FIRING A MISSILE[121]

Once the Army Air Defense Command Post received word from ARADCOM of impending attack, it notified its battalions. As the target entered the range of the acquisition radar and the missiles at each battery were readied for launching, the blue status was sounded, signalling that all personnel should go to battle stations. Three missiles were brought above ground, one at a time, on the elevator, and pushed to the satellite launchers and locked into place with pins. The fourth missile was brought to the surface on the elevator, where it could also be launched.

The chief of the launching section removed the air regulator safety pin and the missile support yoke safety pin. The launching crew checked for stray voltage and continuity at the detonator receptacle on the launchers with the squib (or detonator) tester. If the squib test readings were within acceptable tolerances, the launching crew made the connections and removed the booster squib shorting plug. The chief of the section then announced over the intercom: "Launcher 1, 2, 3, and 4 ready."

An Army public relations film on Nike Hercules provides a visual re-creation of the firing of a missile. Safety was the central theme stressed in the film. Among the precautions that were employed were a series of color-coded streamers that were attached to critical plugs and keys. For example, red streamers were attached to those missile parts that had to be removed before the missile could be launched. Even when the streamers were removed by fire unit personnel to ready the missile for firing, it took a special set of keys to unlock the "awesome power" of the missile system.[122]

After preparing the missiles for launch and checking the area to ensure all personnel were below, the section chief descended into the underground personnel room, closing the escape hatch cover behind him. The section chief then entered the magazine room, closed the vents, and returned to the personnel room, securing the blast-proof doors. He checked the pin board to make sure all the safety pins and the booster squib shorting plug were present. At that time, he also inserted the crew safety keys and placed them in the FIRE position. At the launching control console, there was a green READY light for each section, and a green numbered launcher identification light for each section in action. The MISSILE PREPARED meters for each section indicated the number of missiles ready for launch in each section.

As the target came within range of the acquisition radar, the battery control officer corroborated the target appearing on the plan position indicator with the early warning plot data received from the Air Defense Command Post. At this time, the alert status switched from BLUE to RED. The battery control officer and the acquisition radar operator designated the target to the target tracking radar, and interrogated it by using the identification friend-or-foe facilities on the console. The target had to be identified as FOE during the sequence of events prior to FIRE.

The missiles were raised to a vertical position. The missile tracking radar shifted to the designated missile and cast its electronic beam onto it. The battery control officer determined the proper time to fire the missile – using the plotting board information, his knowledge of the restricted areas in his defense area, the geographic limitation of his field of fire, and the method of engagement directed by the Army Air Defense Command Post. The READY TO FIRE lamp in the battery control console presented a visual summary of the state of readiness of the guidance and launching area. When the missile tracking radar and target tracking radar were engaged, the computer was on line, and the target was identified as FOE, the READY TO FIRE lamp changed from amber to green. After these events, the battery control officer could then fire the missile. If necessary, he could also designate the target as a friend, by pressing the FRIEND button at the acquisition radar control panel. The battery control officer could also designate a new target that had priority by placing the DESIGNATE-ABANDON switch in the ABANDON position. If the target was abandoned, the battery control officer had to designate a new target.

Historian Merle T. Cole, in his description of a Nike installation in the Maryland air defense area, described the order in which the missiles were fired:

> *During a fire mission the missile on the elevator-launcher of one launching section is fired, followed by the missile[s] on the elevator-launcher[s] on the [second and third sections]. Using this sequence each section can reload the elevator-launcher while the other two sections are firing, and consequently maintain the maximum rate of fire. This procedure is followed as long as missiles are available in the underground [magazines]. When these have been exhausted, the three missiles located on satellite launchers at each section are fired as desired by the [battery] commander.*[123]

When the battery control officer operated the FIRE button, the missile was launched. The horizontal plotting board, previously plotting point of intercept, plotted missile position. The vertical plotting board plotted altitude versus time of flight. The MISSILE AWAY green lamp lit at the section control panel and launching control console. The LAUNCH light changed from amber to green at the target tracking, missile tracking radars, and the battery control console, after the missile tracking radar detected the missile movement. Four seconds after MISSILE AWAY (LAUNCH order plus five seconds), the computer ordered the missile to execute a 7g dive (1g is equal to 32.2 feet/second), and at the same time modified this order, if necessary, to insure that the missile ground path was parallel to the line between the launcher and the intercept point. At the instant the computer determined that the missile was on trajectory in the climb-dive direction, and was safely beyond the missile tracking radar (so there was no longer any danger of the radar losing the missile due to excessive angular rates), missile and target information computed steering orders that kept the missile on course. These steering orders were transmitted to the missile via the missile tracking radar by frequency modulating its pulse repetition frequency.[124]

At a predetermined interval, before the time of intercept reached zero, the computer circuits energized, and the BURST signal was transmitted to the missile. The arming device that detonated the warheads was initiated. In the event of missile malfunction or the separation of a missile from the missile tracking radar beam, from two to seven seconds later, a fail-safe circuit in the guidance section energized the squib and detonated the warheads. The detonating process, propagated from the electric detonator in the arming mechanism, through the detonating cord, initiated the individual warheads. In the launching area, there was no visual indication of this command. In the guidance area, the BURST lamps at the battery control, missile tracking, and target tracking consoles, changed from amber to green.

D. RATE OF FIRE[125]

The Nike system could sustain a rate of fire of one missile per minute for one hour against targets at moderate ranges (approximately 25,000 yards) and, if required, a rate of two missiles per minute for short periods against short range targets (approximately 15,000 yards). The actual rate of fire that could have been attained at any one time was dependent upon the circumstances prevailing at the time.

At the time of an initial target, Nike crewmen needed a minimum of thirty-six seconds to launch the first missile. This included approximately thirty seconds to acquire, identify, designate, and track a target; four seconds for computer settle; and two seconds for the fixed time interval between the initial fire order command and the launch of the missile. The missile was designated, acquired and accepted, during the same thirty-second interval as the target.

After the first missile fired, successive missiles could be fired at the same target approximately nine seconds after the bursting or abandonment of the preceding missile. This short time interval was possible because the same target was tracked and no additional time was necessary to acquire, identify, designate, and track a new target. For short ranges, a firing rate of two missiles per minute was possible, but would necessitate the firing of missiles from the satellite launchers. This rate was attainable for only short periods of time as the rate did not allow enough time to reload between launchings. The rate of one missile per minute did have an interval long enough between successive launchings from the same launcher to reload.

After the firing of a missile, a new target could be engaged, and a new missile launched, approximately eleven seconds after the bursting or abandonment of the previous missile. After the previous target has been tracked, the acquisition radar operator was free to examine and interrogate any new targets. After the previous missile was launched, the battery control officer was free to make his decision regarding a new target during the flight time of the missile.

There were two situations in which a missile could be rejected. The missile tracking radar could fail to get a strong enough signal response from the missile (and the TRACK light failed to light), or the missile did not fire within five seconds after a FIRE command signal had been sent from the battery control area. As soon as the red REJECT lamp (or a green MISSILE AWAY lamp) lit, the elevator was lowered and the rejected missile was taken away and missile number 5 was placed on the elevator launcher. Yellow and blue alert checks were made as soon as possible.

X. TRAINING AND INSPECTION

All personnel for Nike batteries trained at the Army Air Defense Center at Fort Bliss, Texas. Fort Bliss and its firing ranges extended north and northeast into New Mexico, toward Alamogordo. At the Army Air Defense Center, Nike personnel studied each element of the Nike system. Commanders were given an overall picture of the missile system and their responsibilities. Radar personnel trained on radar equipment, and each battery underwent a series of tests. Nike personnel also participated in test firings of missiles at White Sands Missile Range, which occupied approximately 1200 square miles of desert land in New Mexico. No Nike missile was ever fired from a U.S. installation, other than for training purposes at White Sands. The only exceptions were firings in Alaska to test the operation of Nike equipment under the cold weather conditions, and an accidental firing in New Jersey.

Annual service practice, also called short notice annual practice, was initiated in July 1961 to enable batteries to fire a missile and to test their proficiency. As part of this practice, batteries traveled to Fort Bliss on only forty-eight-hour notice. Once there, the units had one week to set up equipment, assemble, emplace, and fire their assigned missiles. Because batteries were selected at random, no one ever knew when they would be called and, therefore, could not "cram." Therefore, each battery had to maintain a high state of readiness. Competition for the annual high score was intense.[126]

When not participating in annual practice, unless the battery was "hot," meaning that it was on duty twenty-four hours a day, Nike servicemen often reported that life at the missile installations could be tediously boring. Most Nike bases did have a basketball court to relieve excess energy. (See HAER No. IL-116-N.) Sometimes, softball teams would play against teams in the community, or football teams would be set up within the Army to play one another.[127]

Inspections, planned or unplanned, broke up some of the monotony. From its inception, ARAACOM relied heavily on inspections to determine the effectiveness of its units. There were two types of inspections. The first was a formal command inspection of all assigned units conducted by the commanding general. The second consisted of an instruction visit by staff officers to units which required emphasis in some particular facet of training. ARAACOM designed these inspections to accomplish the following functions:

a. Determine the degree at which standards were attained in the fields of personnel and administration, training and operational readiness, intelligence, and logistics in order that the effectiveness of units could be constantly evaluated.

b. Correct improper procedures by on-the-spot instruction.

c. Insure that policies and directives from ARAACOM and higher echelons of command were being executed.

d. Ascertain the existence of problems beyond the capability of local commanders to resolve.[128]

To determine the value of the inspection system, both ARAACOM and its subordinate headquarters conducted follow-up inspections. Their purpose was to establish, under centralized control, a means for insuring that effective utilization had been made of the information contained in original inspection reports.

Another type of inspection, which tested the firing units, was a BLAZING SKIES alert. These inspections could be either scheduled or surprise alerts, and sometimes occurred as often as once a week. As part of the alert, a randomly chosen aircraft entering the defense area could be designated an intruder, and all firing procedures, short of missile launch, were performed. In addition, the Air Force Strategic Air Command and the Aerospace Defense Command periodically provided "faker" aircraft to simulate enemy aircraft for battery training. The Strategic Air Command combat crews benefitted from these exercises, as they were also scored on target run and evasion techniques.[129]

XI. DEACTIVATION

Nike Missile Base C-84 was closed in 1963, and was one of the first bases closed in the Chicago defense system. As reported by the Chicago Tribune, the Nike Ajax base was deactivated because it could not accommodate the larger Hercules missiles. Like C-84, several other Nike installations in the Chicago area - including bases in Chicago, Naperville, Munster (Indiana) and at Argonne National Laboratories - had also been manned by National Guard units. However, since these sites were converted to accommodate Hercules missiles, they remained active until 1971.[130]

On June 10, 1963, Lake County began renting Base C-84 from the U.S. Army for the purposes of civil defense, records storage, and as an auxiliary highway department site. The property was declared government surplus in 1964. On November 26, 1965, the Government Services Administration quit claimed the 26.87 fee simple acres and the 0.18 acre access and utility easements to the County of Lake, Illinois. Lake County paid $31,051 for the fee simple acres. In 1969, Lake County sold the Control Area portion of the base, which was comprised of 11.07 acres, for $67,583.00.[131]

At the time of the HAER recordation, Lake County was offering the Launch Area for sale, with a minimum purchase price of $550,000. A caretaker lives on the site, but the area is otherwise vacant. In recent years, proposed uses for the base have included an expansion of the County Youth Home, the location for the county jail's work release program, and a shooting range for the sheriff's police.[132] Several former Nike bases in the Chicago defense area have already been converted to new uses. At Arlington Heights, Illinois, a former Nike installation was converted into a golf course; the missile silos were filled and planted over. In Orland Park, Illinois, a Nike base was converted into a civil defense center.

Other Nike bases around the country have also been converted to non-military uses. The Parks and Recreation Department of Southfield, Michigan, incorporated a Nike base into a greenbelt park area. The County of Lake, Ohio, uses Nike magazines for maintenance garages. In Wilmington, Ohio, a Nike site has been converted to a rehabilitation center. A private company in Wisconsin utilizes Nike magazines for explosive materials storage. The U.S. Bureau of Mines in Farmington, Minnesota, uses the magazines for mining research. In California, a former Nike base houses prisoners for the Department of Corrections. In addition, Nike Missile Base SF-88L at Fort Barry in Golden Gate National Park near San Francisco, California, has been partially restored and is open for guided tours on the first Sunday of every month.[133]

In 1974, the nation's last forty-eight Nike batteries were phased out, although four batteries of Hercules were retained for troop training in Florida and Alaska. Overall, the total production of the Nike Hercules amounted to over 25,000 missiles, of which 2,650 were exported under the Foreign Military Sales Program and 1,764 under the Military Aid Program.[134] Japan phased out its last Nike Hercules in November 1992.[135] Its replacement, the Patriot missile, was deployed starting in 1984.[136] Patriot's fast reaction capability, high firepower, and ability to operate in severe electronic countermeasure environments provides an effective low-to-high altitude air defense for the modern battlefield.

XII. NIKE BASES IN THE CHICAGO-GARY DEFENSE AREA SYSTEM

Total in Chicago-Gary Defense Area system: 23 (18 in Illinois, 5 in Indiana)

Note: Bases C-49 and C-50; C-80 and C-81; and C-92 and C-94 were historically often counted together as single bases.

Number	Location	County
C-03	Chicago (Belmont Harbor, Montrose Beach)	Cook, IL
C-40	Chicago (Burnham Park, Lake Shore Dr. & 23rd St.)	Cook, IL
C-41	Chicago (Jackson Park, S. Shore Dr. & 63rd St.)	Cook, IL
C-44	Chicago (Wolf Lake, near Indiana state line)	Cook, IL
C-49/C-50	Homewood	Cook, IL
C-51	Alsip	Cook, IL
C-54	Orland Park	Cook, IL
C-61	Argonne National Laboratories (Near Tri-State Village)	Du Page, IL
C-70	Naperville	Du Page, IL
C-72	Addison	Du Page, IL
C-80/C-81	Arlington Heights/Rolling Meadows	Cook, IL

C-84	Barrington	Lake, IL
C-92/C-94	Libertyville	Lake, IL
C-93	Skokie Lagoons (Near Glencoe)	Cook, IL
C-98	Ft. Sheridan (Near Highwood)	Lake, IL
C-32	Porter	Porter, IN
C-45	Gary (Gary Municipal Airport)	Lake, IN
C-46	Munster	Lake, IN
C-47	Hobart	Lake, IN
C-48	South Gary	Lake, IN

XIII. CITIES AND SITES PROTECTED BY NIKE INSTALLATIONS

Abilene, Texas
Albany, Georgia
Anchorage, Alaska
Austin, Texas
Baltimore, Maryland
Barksdale AFB, Louisiana
Boston, Massachusetts
Buffalo - Niagara Falls, New York
Chicago, Illinois
Cincinnati - Dayton, Ohio
Cleveland, Ohio
Dallas - Fort Worth, Texas
Detroit, Michigan
Ellsworth AFB, South Dakota
Fairbanks (Fort Wainwright), Alaska
Hanford Reservation (Department of Energy), Washington
Hartford, Connecticut
Kansas City, Missouri
Key West, Florida
Loring AFB, Maine

Los Angeles, California
Miami (Homestead AFB), Florida
Milwaukee, Wisconsin
Minneapolis-St. Paul, Minnesota
Mountain Home AFB, Idaho
New Haven, Connecticut
New York, New York
Norfolk, Virginia
Oahu, Hawaii
Omaha - Lincoln, Nebraska
Philadelphia, Pennsylvania
Pittsburgh, Pennsylvania
Providence, Rhode Island
Robins AFB, Georgia
San Francisco, California
St. Louis, Missouri
Seattle, Washington
Spokane, Washington
Walker AFB, New Mexico
Washington, D.C.

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92.Memorandum: Report of Nike Sites Advertised, 12 April 1954, Office of History, Corps of Engineers, Fort Belvoir, VA; ENGMN 4666, Memorandum, 22 April 1954, Office of History, Corps of Engineers, Fort Belvoir, VA; Memorandum: Proposed Nike Deployment and Site Availability Plan, 6 April 1955, Office of History, Corps of Engineers, Fort Belvoir, VA; and CONUS NIKE Program, Memorandum: Proposed Nike Deployment, 3 December 1955, Office of History, Corps of Engineers, Fort Belvoir, VA.

93.United States Army Corps of Engineers, Chicago District. "Defense Environmental

Restoration Program Inventory Project Report," Project No. E05IL007700 (n.d.), U.S. Army Corps of Engineers Office, Chicago District, Chicago, IL.

94. Oliver P. Prost, Comptroller, U.S. Army Engineer District, Chicago, Memorandum: To ENGMC-CO, 5 June 1962, Office of History, Corps of Engineers, Fort Belvoir, VA.

95. Environmental Science and Engineering, Inc.

96. James A. Sawicki, Antiaircraft Artillery Battalions of the US Army, Volume I (Dumfries, VA: Wyvern Publications, 1991); and Directory and Station List of the U.S. Army, Center of Military History, Washington, D.C.

97. In the October 15, 1959, Station List, a Palatine site (no site number given) is listed as Battery C for the 3rd Artillery, 6th Missile Battalion, Nike-Hercules. Nike Site C-84 was sometimes referred to as being in Palatine, a neighboring community. (It was also referred to as the Lake Zurich site). However, simultaneously, Site C-84 is included as Battery D for the 60th Artillery, 2nd Missile Battalion, Nike-Ajax. Given the information available regarding the use of C-84 solely as a Nike-Ajax Battery, the placement the "Palatine" site, Nike Site C-84, under a Nike-Hercules Battalion appears to be an error.

98. R.E. Vollendorff, Colonel, GS Office, Chief of Legislative Liaison, to Honorable Marguerite Stitt Church, U.S. House of Representatives, December 28, 1961, Office of History, Ft. Belvoir, VA.

99. Annual Report, Report of the Chief National Guard Bureau (Washington, D.C.: Center of Military History, 1957).

100. Annual Report, Report of the Chief National Guard Bureau (Washington, D.C.: Center of Military History, 1961).

101. Cole, 242.

102. Brochure issued for 29 January 1958 presentation to Lieutenant Colonel Adam J. Eisenhauer, by the 32nd Antiaircraft Artillery Brigade, U.S. Army stationed in West Germany, in the files of the Center of Military History, Washington, D.C.

103. The Antiaircraft Artillery and Guided Missile School, Battery Control Circuits and AGTransmission Circuits (ST 44-161-3G) (Fort Bliss, Texas: November 1955), 4-5.

104. The Antiaircraft Artillery and Guided Missile School, Introduction to Nike I System (ST 44-161-1), 13.

105. Ibid.

106. The Antiaircraft Artillery and Guided Missile School, Battery Control Circuits and AG Transmission Circuits (ST 44-161-3G), 5.

107. Ibid.

108. Ibid.

109. Ibid.

110. Gunston.

111. Cagle, Historical Monograph, 187.

112. The Antiaircraft Artillery and Guided Missile School, Battery Control Circuits and AG Transmission Circuits (ST 44-161-3G), 6.

113. Sage, et. al., 30.

114. The Antiaircraft Artillery and Guided Missile School, Underground Launching Equipment (ST 44-161-3I) (Fort Bliss, Texas: October 1955), 3.

115. Department of the Army, Nike I Systems: Nike I Round Launching Area and Assembly Area Equipment (TM 9-5000-4) (Headquarters: April 1956), 27.

116. Ibid.

117. Ibid.

118. Ibid.

119. Much of the information in this section is taken from: The Antiaircraft Artillery and Guided Missile School, Battery Control Circuits and AG Transmission Circuits (ST 44-161-3G), 7.

120. Ibid., 7-8.

121.Ibid., 11-24.

122.United States Army, The Nike-Hercules Story, produced by Herbert Kerkow, Inc., New York, NY, presented by Bell Telephone Co., n.d.

123.Cole, 251.

124.The Antiaircraft Artillery and Guided Missile School, Introduction to Nike I System (ST 44-161-1), 57.

125.The Antiaircraft Artillery and Guided Missile School, Battery Control Circuits and AG Transmission Circuits (ST 44-161-3G), 8-9, 24.

126.Cole, 254.

127.James W. Dunn, Historian, Fort Belvoir, VA, interviewed by Christina M. Carlson. Mr. Dunn was a 2nd Lieutenant at a Nike site in Los Angeles, CA.

128.Barnard, 171-2.

129.Cole, 254.

130.Chicago Tribune, 18 May 1973; and "Certain Mileposts Re: Nike Site New Lake Zurich (n.d.) photocopy, files of the Lake County Museum, Wauconda, IL.

133.Nike Missile Site C-84 files, Lake County Museum, Wauconda, IL; and United States Army Corps of Engineers, Chicago District, "Defense Environmental Restoration Program Inventory Project Report," Project No. E05IL007700.

132.Lake Zurich ((IL) Daily Herald, 23 January 1992; and Pioneer Press, 21 November 1985, in the files of the Lake County Museum, Wauconda, IL.

133.Sage, et. al., 1; and Richard J. Sommers, Department of Army, Carlisle Barracks, PA, to Christina Carlson, October 1992, transcript in files of Christina Carlson, Bregman & Company, Inc., Bethesda, MD.

134.Duncan S. Lennox, ed., Jane's Strategic Weapons System (Surrey, United Kingdom: Jane's Information Group, 1990), and Gunston.

135.Tim O'Gorman, Curator, U.S. Army Air Defense Artillery Museum, Ft. Bliss, TX, interviewed by Christina M. Carlson.

136. Lennox; and Gunston.